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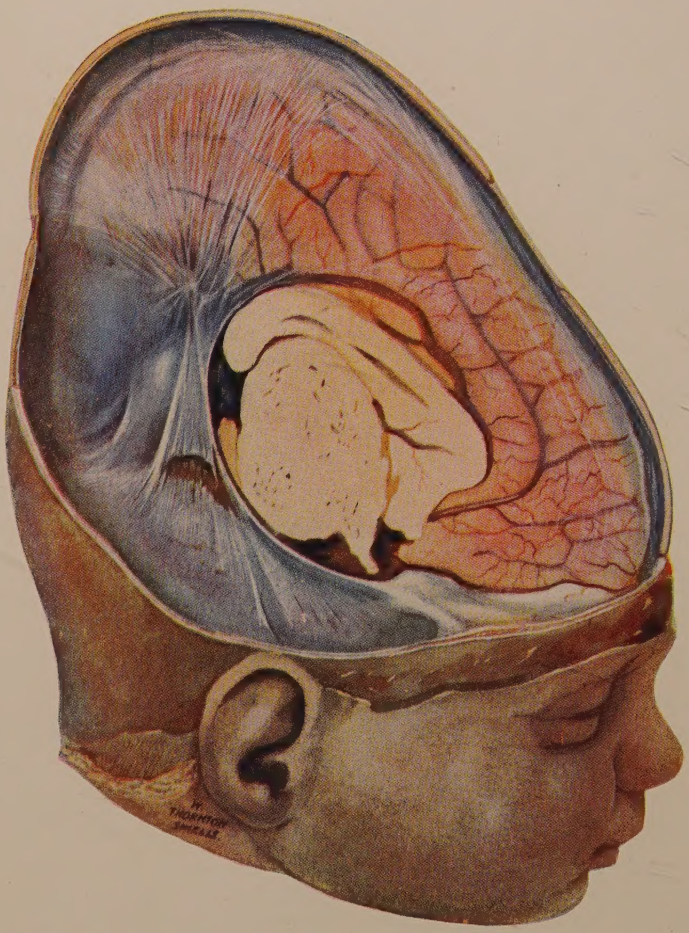

Tear of Tentorium Cerebelli on right side; the tear is across the fibres near the junction with the Falx Cerebri. The head shows extreme moulding after labour with generally contracted pelvis. Note elevation of apex of Tentorium and change in directions of Vein of Galen and Straight Sinus.

[*Frontispiece.*

A MANUAL OF MIDWIFERY

BY

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EXAMINER IN MIDWIFERY AND DISEASES OF WOMEN IN THE UNIVERSITY OF CAMBRIDGE AND TO THE CONJOINT BOARD OF ENGLAND
LATE EXAMINER IN THE UNIVERSITIES OF LONDON AND DURHAM

SIXTH EDITION

With 7 Plates and 393 Illustrations in the Text

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PREFACE TO SIXTH EDITION

Dr. Eden greatly honoured me when he asked me to undertake the preparation of this edition, and to be responsible for such revision, alteration and addition as I might think necessary and appropriate. I realised my responsibility would be doubly great, because the book possessed the two-fold distinction of matter and of style. I have been at pains to make an harmonious blend of my new with his original matter, and hope readers will find the narrative to run throughout as smoothly as if written by a single pen. Every part has been subjected to careful scrutiny, and the revision has been general. Although new sections have been added and certain important subjects have been rewritten, and the number of illustrations has been increased by twenty-four, it has been possible, by judicious pruning and compression, to reduce the original number of pages by forty—an advantage to the student of to-day, who is concerned about the growth of his curriculum and the burden of his reading.

As this is the first edition of the co-partnership of Dr. Eden and myself, it will be well to make an orderly statement of the chief changes made.

In Part I. (Normal Pregnancy) the section on the early development of the ovum has been shortened, and recent work on the early development of the anthropoid ovum, up to the period of development when early human ova are available for study, has been incorporated. New sections have been added on the functions of the placenta, on the general physiology of the fœtus, on changes in the maternal metabolism during pregnancy, and on the diagnostic value of X-rays.

In Part II. (Abnormal Pregnancy) the sections dealing with the toxæmias of pregnancy have been largely rewritten, especially those which deal with the theories of causation, the chemical changes in the blood and urine, the modern methods of testing renal efficiency and, above all, the treatment of eclampsia. Full use has been made of the results obtained by

the recent collective investigation into eclampsia. The conservative treatment has been described in the requisite detail; but, at the same time, this difficult part of the subject has been treated judicially, and the scales have been fairly held in weighing the respective merits of the 'medical' and the 'surgical' schools. More space and a coloured plate have been devoted to diseases of the placenta. The section on syphilis has been rewritten, and the pathology of fœtal syphilis has been transferred to the new Part VI., which deals with fœtal pathology.

In Part III. (Normal Labour) what may be thought to be a new description of the bony 'pelvic outlet' will be found; it is, however, the old description, in which the outlet was regarded as the inferior 'strait' of the pelvis, *i.e.*, the lowest segment of the pelvic cavity, bounded above by the narrowest plane, at the level of the ischial spines, and below by the boundaries of the anatomical bony outlet. This conception of the pelvic outlet at once makes clear the manner of obstruction to the head in labour with slight degrees (the common ones) of general pelvic contraction and with outlet contraction. The management of occipito-posterior presentations with extension of the head has been transferred to its proper place in Part IV. Special emphasis is laid on the advantages of rectal over vaginal examination.

In Part IV. (Abnormal Labour) the section on breech presentation has been revised and amplified, and has received new illustrations. Contraction of the pelvic outlet receives more attention than in former editions.

In Part V. (The Puerperium) puerperal infections have been partly rewritten. The old division of uterine infections into 'sapræmia' and 'septicæmia' is discarded, and they are grouped into 'slight' and 'severe' forms, the latter with or without a secondary septicæmia. As 'primary septicæmia' are designated those usually fatal fulminant cases in which the infection becomes generalised from the very first. The importance of accurate diagnosis by bacteriological investigation of the uterine cavity at the first onset of severe symptoms is given a prominent place. Unfortunately there has been little of note to add on treatment.

Part VI. (The New-born Child) has been subjected to a general revision, with the able assistance of Dr. Harold Waller. Breast feeding and all its possible difficulties are carefully

described, and the simple forms of artificial feeding receive due attention ; but for the complexities of artificial feeding and of substitute foods the student is referred to text-books on pediatrics. As in former editions, no mention is made of infant disease beyond what may be termed disease and injury of obstetrical origin. Criticism may be made that this part of the book should have been amplified, but this is a text-book of obstetrics and not of pediatrics.

Part VII. is a new part, which deals with ' Diseases, Injuries and Death of the Fœtus.' Asphyxia neonatorum, essentially a fœtal and not an infant state, finds its proper place here. The words ' fœtus ' and ' infant ' are carefully defined, as also are the terms ' live-birth ' and ' dead-birth ' (preferred to ' still-birth '). Throughout the book pains have been taken to use the words ' fœtus ' and ' infant ' in their correct sense, and not, as is usual, synonymously. Pulmonary respiration, and not heart-beat, is taken as the sign of ' live-birth,' and death of the fœtus before it has breathed, even if its heart is beating at birth, is adopted as the definition of ' dead-birth.' It is hoped that this definition may become generally adopted by the medical profession and for statistical purposes, and ultimately by jurists. Pulmonary respiration truly marks the transition from the intrauterine existence of the fœtus to the independent existence of the infant, and is a sign easily recognisable even by untrained persons. The causes of fœtal death have been classified and described, and especial attention is paid to intracranial injuries, cerebral hæmorrhage, asphyxia, and syphilis.

The only noteworthy changes in Part VIII. (Obstetric Operations) are in the sections on Forceps and Cæsarean Section. The indications and contra-indications for the use of forceps are more fully discussed than in former editions, and a special plea is made in favour of the accurate ' cephalic ' application of the blades, whereby the risk of intracranial injury is reduced to a minimum. The account of Cæsarean section has received the benefit of the results gained by the collective investigations of 1920 and 1921. The operation in which the incision is made in the lower uterine segment is described, and the subject of rupture of the scar receives more than passing notice.

Part IX. is a new part, which deals shortly with the statistics of the maternal mortality of childbirth, with the various forms of maternal ill-health which may result from childbirth, and

with the purpose and methods of 'antenatal supervision.' Although the general management of pregnancy is considered in Part I., the section on antenatal supervision, and all it implies, has purposely been left to the last; for the student can better appreciate its great advantages after he has been made familiar with the complications of pregnancy and labour, and with the methods of preventing them, and has been impressed with the evil consequences which may arise in the absence of such supervision.

I am much indebted to my friend Dr. Harold Waller for his assistance in the revision of the pages devoted to the new-born child, and to my former colleague, Mr. Victor Lack, for some valuable suggestions. To Mr. M. H. Jupe, of the Radiological Department of the London Hospital, I am indebted for three beautiful radiograms. Mr. Thornton Shiells has made the new coloured plates and drawings with the artistic skill which is so well known to readers and writers of modern medical books.

Eardley Holland.

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Part I

NORMAL PREGNANCY

Ovulation

The ovary is the storehouse in which egg-cells (oocytes) are preserved, and from which they are periodically liberated during the years comprised between puberty and the menopause. *Ovulation* is the process by which oocytes are discharged from their protecting chambers—the Graafian follicles—into

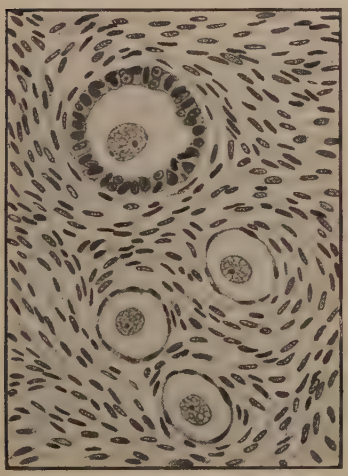


Fig. 1.—Resting follicles below and follicle just beginning to ripen above. × 200.

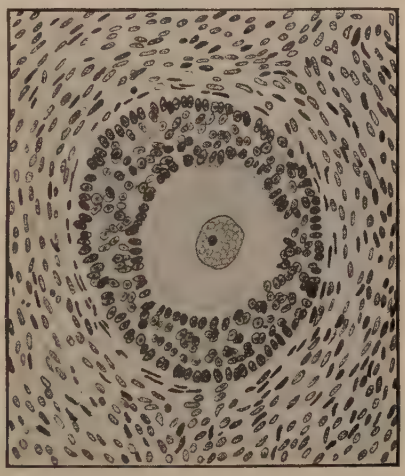


Fig. 2.—Follicle in further stage of ripening, surrounded by several layers of membrana granulosa cells. × 200.

the peritoneal cavity; this process includes the two stages of maturation (ripening) and dehiscence (rupture) of the follicles. A follicle in the resting phase (*i.e.* before ripening has begun) consists of the oocyte surrounded by a layer of flattened epithelium and lies deeply in the cortical layer of the ovary, separated from the surface by a layer of ovarian tissue of variable thickness. In the ripening process the epithelium becomes converted into a layer of cuboidal cells (the *membrana granulosa*) which soon proliferate, so that the oocyte is sur-

rounded by a number of layers (Figs. 1 and 2); a cavity containing a clear albuminous fluid (the *liquor folliculi*) then appears amidst the granulosa cells, and the oocyte, surrounded by a mass of cells forming the *discus proligerous*, becomes displaced to one side of the follicle. As ripening progresses two other changes occur: (1) The follicle first approaches the surface, and finally becomes partly extruded, forming a pro-

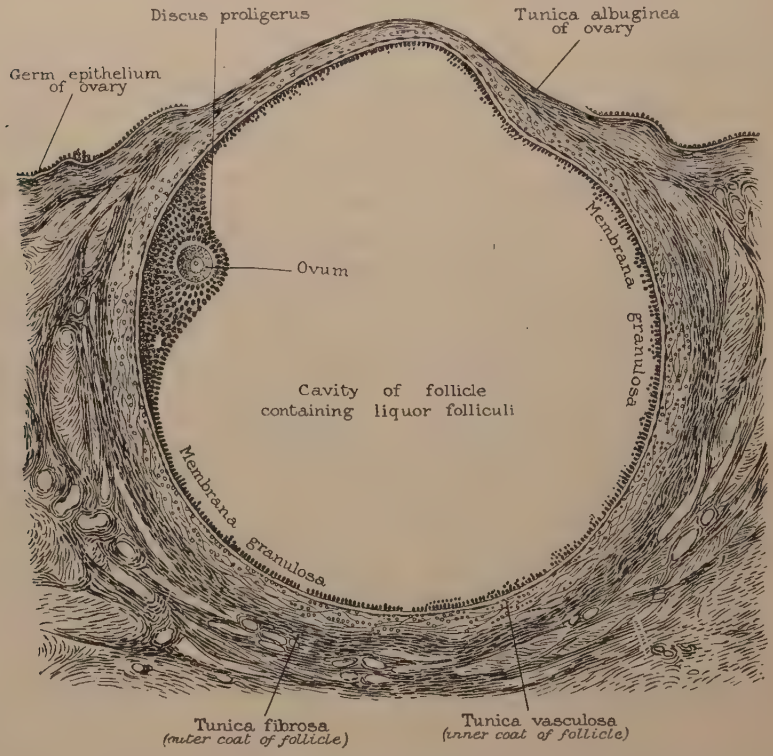


FIG. 3.—Ripening Graafian Follicle protruding upon the Surface of the Ovary. (Bumm.)

tuberance on the ovary, the germ-epithelial covering at that spot being lost; (2) it increases greatly in size. The structure of a ripening follicle is shown in Fig. 3. The process of extrusion has not been fully studied, but there occurs an undoubted displacement of the enlarging follicle towards the surface. The causes of rupture are also obscure and probably complex, and many different views concerning them have been advanced. A great increase in the amount of liquor folliculi occurs during ripening, partly by transudation from the congested ovarian

vessels, and partly perhaps by secretion from the proliferating cells of the granulosa ; towards the end of the process hæmorrhage may also occur into the follicle, causing a sudden increase in tension which would easily determine rupture. In addition, degenerative processes of the nature of necrosis occur in that part of the wall of the follicle which lies exposed upon the surface, and is unsupported by the ovarian stroma, which so weaken it that it is unable to resist the high tension within, and rupture results. Rupture is therefore due to weakening from degeneration of the wall of the follicle, combined with increased intra-follicular tension.

When the follicle ruptures, the contained fluid escapes and as a rule carries the oocyte with it into the peritoneal cavity. Occasionally two and sometimes three oocytes are found in a Graafian follicle. Sometimes Graafian follicles may rupture without detachment of the oocyte occurring ; this gives the opportunity for ovarian pregnancy to arise if spermatozoa should chance to enter the ruptured follicle (see p. 159) ; otherwise the oocyte would perish *in situ* and non-detachment thus become a possible cause of sterility, but we have no definite information upon this point. The human oocyte is a large cell, 200μ in diameter, consisting of a cell envelope, the protoplasm, the nucleus and the nucleolus. The cell envelope is a transparent structureless zone in which fine striations are visible and is known as the *zona pellucida* or *radiata ;* the protoplasm contains coarse granules of *deutoplasm* or yolk, which possess nutritive properties ; the nucleus is large and clear and is known as the *germinal vesicle*, and the nucleolus is known as the *germinal spot*. An oocyte sometimes contains two nuclei, and the nucleolus is not infrequently double. The human oocyte, after its escape from the follicle, is shown in Fig. 4 ; it retains a covering of several layers of cells, the *corona radiata*, derived from the discus proligerus, which serve to protect it during its transit to the Fallopian tube ; in the tube this protective covering disappears. An oocyte with the above characteristics is described as mature, but it is not capable of fertilisation and development until the polar globules have been formed and cast off.

After its discharge from the ovary the oocyte migrates into the Fallopian tube. It was at one time thought that during ovulation the fimbriæ of the abdominal ostium became turgid like erectile tissue and spread over the ovary like the fingers of the hand, so that the ovum was discharged directly into the mouth of the tube itself. This view appears to rest upon fancy, and is opposed to established clinical facts. We know now that the oocyte does not always enter the Fallopian tube of the same side, but may pass across the pelvic peritoneal cavity and enter the opposite tube. This phenomenon, known

as 'external wandering,' has been demonstrated by cases in which a woman has become pregnant after losing the ovary of one side and the tube of the other; the discharged oocyte must, in such cases, pass across the pouch of Douglas. The distance between the ovary and the mouth of the opposite Fallopian tube is not great, and may be reduced by the pelvic congestion accompanying ovulation. The oocyte has no locomotive power of its own, and must be carried by peritoneal currents from the ovary to the tube. There is no difficulty in believing that such currents exist in the neighbour-

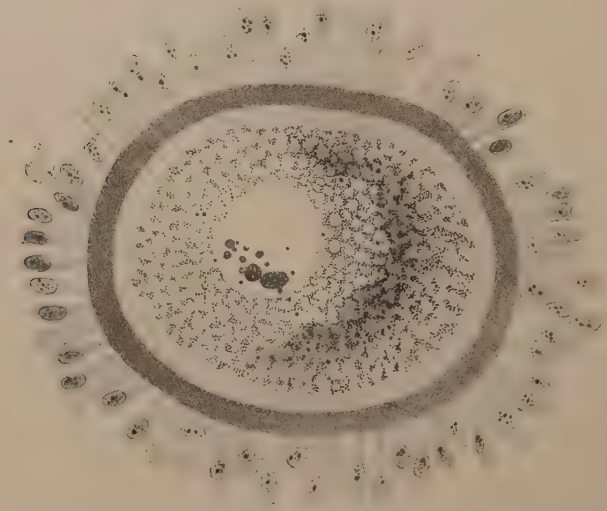


FIG. 4.—Human Oocyte showing the Corona Radiata, Zona Radiata. Granular Protoplasm, Germinal Vesicle, and Germinal Spot. × 500. (Van der Stricht, from Galabin and Blacker.)

hood of the abdominal ostia, for the cilia covering the mucous surfaces of the fimbriæ work towards the uterus, and naturally set up currents travelling in that direction in the thin layer of fluid which covers the peritoneum. Their existence in lower animals has been actually demonstrated by injecting insoluble particles into the peritoneal cavity; some of these have afterwards been found in the tubes, having been carried thither by peritoneal currents. When once the oocyte has reached one of the tubal fimbriæ, it is probable that peristaltic contractions of the tubal muscle play a part even more important than ciliary action in passing it on to the uterus.

The Corpus Luteum.—After the Graafian follicle has ruptured and discharged its contents, it undergoes important

changes and is henceforth termed the *corpus luteum*. A great deal of attention has been paid to the structure and functions of this body, which in many respects resembles a ductless gland, and there is evidence that it may normally exert a certain controlling influence upon pregnancy, especially upon the imbedding and early development of the fertilised ovum. Extirpation of the corpora lutea in pregnant animals is invariably followed by abortion, and in the human female pregnancy is nearly always interrupted by double ovariectomy performed during the first weeks of pregnancy. It is also significant that cases of vesicular mole and chorionic cancer,

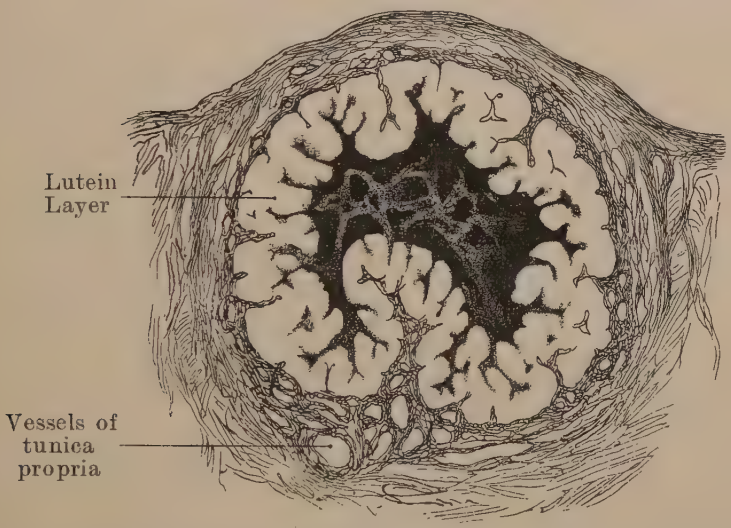


FIG. 5.—Corpus luteum three weeks after Menstruation, showing the Central Blood-clot, the Convoluted Lutein Layer, and the Vascular Tunica Propria. (Bumm.)

in both of which conditions there is abnormal activity of the chorionic epithelium, are often accompanied by an excessive development of lutein cells in the ovaries.

The cavity of the ruptured follicle is at first filled up with blood effused from the site of rupture; the degenerated granulosa cells are mostly cast off, their place being taken by many layers of actively proliferating polygonal cells of epitheloid character, in which a yellow lipoid body called *lutein* has appeared in the form of fine fat droplets, which give the usual staining reactions with osmic acid and Sudan III. These cells are therefore now called *lutein cells*. So well marked are their characters that their presence in a structure of indeterminate nature is sufficient to prove it to be active ovarian tissue. They

arise either from the connective-tissue cells of the tunica vasculosa or from the membrana granulosa. Each of these views has its advocates, but the more recent observations have been unanimously in favour of their origin from the follicular epithelium. Owing to the collapse of the follicle after evacuation of its contents, the wall becomes convoluted along its entire length from the formation of folds, and the lutein layer thus comes to acquire its characteristic sinuous outline (Fig. 5). Subsequent changes consist in the absorption of the central blood-clot, the complete occlusion of the cavity by proliferating lutein cells, and gradual shrinkage of the entire body. It has been shown that masses of lutein cells can often be found scattered through the ovarian stroma during pregnancy, so that their function is probably not limited to the repair of the ruptured Graafian follicle. Later on the cells of the corpus luteum become largely replaced by connective tissue which invades it from the surrounding ovarian stroma (*corpus fibrosum*), and finally this in turn undergoes hyaline degeneration and is converted into white structureless material (*corpus albicans*). Upon the surface of the ovary a small depressed cicatrix persists, indicating the site of rupture of the follicle. The length of time occupied by these changes is variable, becoming longer as age advances; many weeks or months are probably always required for their completion.

During pregnancy the corpus luteum attains a greater size than when pregnancy does not occur; it may continue to increase in size, probably from progressive hæmorrhage, for three or four months, and may come to occupy about one-third of the whole ovarian area. It then gradually undergoes the retrograde changes just described, which are not completed until after the termination of gestation. The large corpus luteum met with in pregnancy was formerly called the 'true corpus luteum,' and that formed when pregnancy does not occur the 'false corpus luteum.' Since there is no essential difference between them, either in structure or in the changes they undergo, these names are meaningless; the one is no more 'false' nor 'true' than the other.

Menstruation

It is undoubtedly true that the processes of ovulation and menstruation are closely related to each other; but whether they are coincident or consecutive, and, if consecutive, which precedes the other, we do not know with certainty. That menstruation is not essential to the occurrence of pregnancy, and that a fertilised ovum may be successfully implanted upon a quiescent endometrium, is well known; for pregnancy may occur either before the establishment of the menstrual

function at puberty, after the menopause, or during a temporary suspension of menstruation such as that which usually accompanies lactation. There is, however, much to be said for the time-honoured view that the uterus is in some way prepared by the menstrual changes for the reception of the fertilised ovum ; for regularity of the menstrual function is the rule in fertile women, and clinical observations indicate the conception, although it may occur at any point in the menstrual cycle, is most likely to occur during the days which immediately follow a menstrual period. From careful clinical observations upon cases in which the ovaries were examined in the course of operations, Fraenkel has expressed the opinion that ovulation ordinarily occurs soon after the close of a menstrual period. This view also receives support from the fact that the changes which the uterine mucous membrane undergoes during menstruation present certain well-marked resemblances to those which immediately follow upon conception and result in the formation of the decidua. So great is the resemblance that many writers now speak of the endometrium during menstruation as the *menstrual decidua*.

The complete menstrual cycle occupies about twenty-eight days, and during the whole time the endometrium is undergoing a series of changes which consist essentially in an alternate breaking down and building up of its superficial layers. The anatomy of menstruation has been studied in human as well as in other mammalian uteri, and the menstrual cycle has been divided into four phases, which merge very gradually into one another : (1) the intermenstrual or resting phase (corresponding to the ancestrum of animals), with an average duration of about twelve days ; (2) the premenstrual phase or period of growth (corresponding to the precestrum of animals) and lasting about five days ; (3) the menstrual phase, a period of degeneration and bleeding (corresponding also to the precestrum of animals), and lasting about four days ; and (4) the postmenstrual phase, a period of repair (corresponding to the œstrus of animals), with a duration of about seven days. It is only during a part of the first phase that the endometrium presents the appearances of 'normal' endometrium, that is, a thin mucous membrane with simple tubular glands and a fine uniform stroma. Towards the end of this phase the endometrium begins to present appearances characteristic of the premenstrual phase. The earliest changes are hyperæmia and swelling of the mucosa, associated with engorgement of blood-vessels, which is most marked in the superficial capillaries (Fig. 6). The glands become elongated and irregularly dilated, presenting a somewhat corkscrew outline ; when seen in longitudinal section the dilated lumen is irregularly divided by transverse septa upon which proliferating epithelium is seen ; the inter-glandular

connective tissue increases in amount, becomes looser in texture, and sometimes shows traces of infiltration with leucocytes. In the more superficial layers the stroma-cells are enlarged and round, and faintly resemble the decidual cells of pregnancy. As the result of these changes in the stroma and

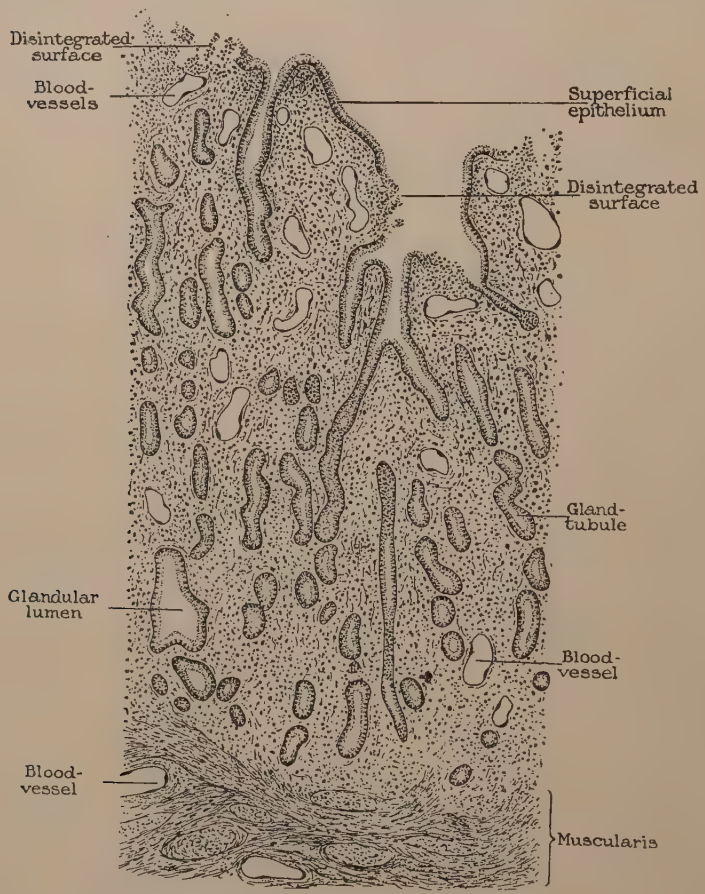


FIG. 6.—Vertical Section of Endometrium during the First Day of Menstruation. (Schäfer.)

glands the endometrium becomes several times thicker than before. Towards the close of the premenstrual phase small interstitial hæmorrhages appear, situated chiefly beneath the superficial columnar epithelium, and the whole endometrium has the character of a blood-sponge. During the menstrual phase the superficial layers degenerate and the blood poured into the stroma bursts through the surface epithelium, and as a

result patches of these cells become thrown off; but the amount of tissue lost in this way is very small. The menstrual flow comes in part from the denuded patches, but probably the whole of the greatly congested mucosa bleeds more or less. In addition a large amount of mucus is produced by the active glands, and this substance forms a considerable part of the bulk of the menstrual fluid. During the postmenstrual phase of repair, the congestion subsides, the damaged surface is repaired, the glands become inactive, and the mucous membrane passes again into the resting phase of quiescence. The mucous membrane of the cervix takes little or no part in these changes.

If an ovum becomes fertilised, further important developments occur in the endometrium, resulting in the formation of the decidua of pregnancy. The most important difference between the mucosa during menstruation and the decidua of pregnancy is the formation in the latter of the characteristic decidual cells; in most other respects the resemblance between them is striking.

Fertilisation, Early Development and Imbedding

The process of fertilisation consists in the union of the male element (spermatozoon or male gamete) with the female element (oocyte or female gamete). From what we know of the process in lower mammals there is reason to believe that the spermatozoon and oocyte usually meet in the Fallopian tube. We have seen that the oocyte may be carried into the tube by peritoneal currents and then passed on by the action of the ciliated epithelium and tubal muscle. The spermatozoon makes its way upwards from the vagina by means of the propelling apparatus with which it is provided, consisting of a long tail which acts like a propeller in driving it forward through the thin layer of fluid which covers the mucous membranes. The activity of the spermatozoa is very great in certain animals, for they can travel from the vagina into the peritoneal cavity in a few hours. It is somewhat doubtful whether their progress is opposed by the action of the ciliated epithelium, for the existence of ascending currents in the secretions of the genital tract has been demonstrated by Bond, who placed insoluble particles of colouring-matter in the vagina, and recovered them in the Fallopian tube on operation a few days later. The time occupied by the transit into the tube in the human species is unknown, but, from comparative observations, it is believed not to exceed twenty-four hours (Teacher). It is possible for spermatozoa to lie in wait for the oocyte in the Fallopian tube for considerable periods; thus they have been found alive in a human Fallopian tube removed three and a half weeks after the last act of sexual intercourse.

Only one spermatozoon is required for the fertilisation of an oocyte, and of the enormous numbers found in the seminal fluid nearly all must perish without achieving their physiological destiny. The fertilised egg-cell is termed morphologically the *zygote ;* it is convenient to call it the *ovum*, a term which may be applied at all stages of its development.

The details of the process of fertilisation naturally cannot be studied in the human species ; most of what we know comes from observations upon certain of the echinoderms (such as the

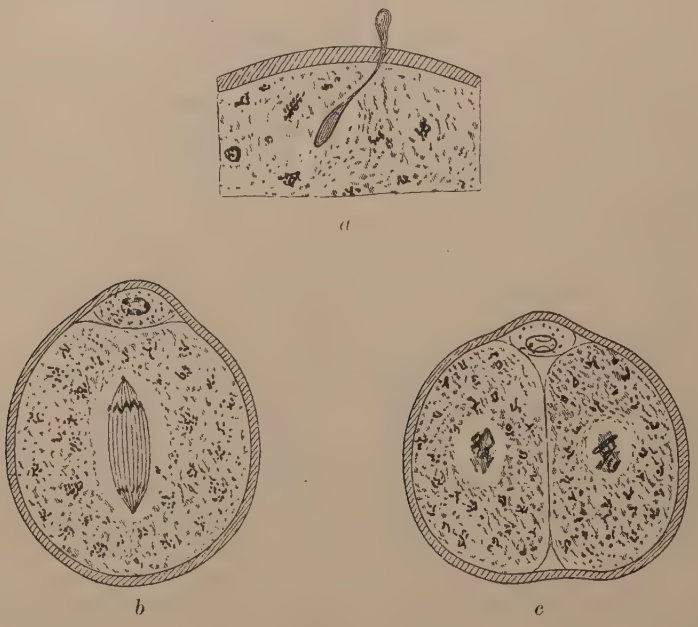


FIG. 7.—The Process of Fertilisation in the Mouse, after Sobotta. (Von Winckel.)

a. Penetration by a spermatozoon. *b*. Formation of polar body, and first division of segmentation nucleus. *c*. Binary division of the ovum.

sea urchin) and ascarides (worms) which possess transparent oocytes, but Sobotta has succeeded in studying fertilisation in the mouse. The matter can only be very briefly referred to here.

Immediately before the union of the spermatozoon and oocyte, certain changes occur in the nucleus (germinal vesicle) of the latter, resulting in the extrusion of one or two minute portions of its substance, with a covering of protoplasm, beneath the zona radiata ; the extruded portions are termed the polar globules, but their significance is quite unknown, and they soon disappear. The polar globules carry with them one

half of the chromatin loops (or chromosomes) which the germinal vesicle originally contained ; consequently the latter when fertilised contains only one half of its proper number. It is possible that this process determines the occurrence of variations in hereditary characters. As the human oocyte possesses no micropyle, such as exists in the invertebrates, the spermatozoon penetrates (Fig. 7, *a*) the zona radiata (*z. pellucida*), and when the head has entered, the tail separates and disappears. The human egg-cell is a large cell 200μ in diameter, and visible to the naked eye ; the head of the spermatozoon measures about 5μ in length. Attention has been paid to the behaviour of the nuclei during fertilisation, and observations on lower animals have established the following facts. The included head of the spermatozoon (*male pronucleus*) and the germinal vesicle of the ovum (*female pronucleus*) each divides into two, and active karyokinetic changes occur. After an interval the four nuclei fuse to form a single nuclear spindle to which an equal number of chromatin loops (*chromosomes*) is contributed by the male and female pronuclei. Every cell formed from the fertilised ovum therefore contains chromosomes derived originally from each parent (Adami). The cell resulting from fusion of the two pronuclei is the *fertilised ovum* or *zygote*.

Early Development.—The fertilised ovum now starts immediately upon a career of extraordinary activity by which all the organs and tissues of an individual human body are formed from it by cell-division and differentiation.

Since the youngest known human ovum is already of the age of about fourteen days, the earliest stages of its development can only be deduced from the data of comparative embryology. The complete process has been studied in a large number of mammalian ova, including those of some of the higher apes, and by comparing these with the earliest known states of the human ovum, the earliest stages of its development may now be stated with a fair amount of accuracy. The process of cell-multiplication in its earliest stages is known as the *segmentation* of the ovum. The segmentation nucleus first divides into halves, which recede towards opposite poles of the cell (Fig. 7, *b*) ; an equatorial or polar line of division is then formed between them which divides the entire cytoplasm in two (Fig. 7, *c*). The same process is repeated in the two new cells, and being continued indefinitely, the ovum multiplies by binary division into 2, 4, 8, 16, 32, &c., cells. In this manner a solid cluster or globe of cells is formed, called the *morula*. In the morula the cells are grouped into a central mass of large cells and a peripheral layer of smaller, clearer cells (Fig. 8). By the accumulation of fluid between the central mass and the peripheral layer the *blastodermic*

vesicle or *blastocyst* is now formed, the wall of which is formed by a single layer of small clear cells, except at the part where the inner mass is attached and projects into the cavity (Fig. 9). It is of the utmost importance to appreciate the destiny of the two sets of cells. The peripheral layer takes no part in the formation of the embryo, but is concerned solely with the embedding and attachment of the embryo ; it is called the *primitive ectoderm* or *trophoblast*. The inner mass provides the cells out of which are formed the embryo, yolk sac, and amnion ; it is known as the inner or *embryonic cell mass*. The further development of these two parts of the blastocyst will be followed separately.

From the inner face of the embryonic cell mass a layer of

FIG. 8.—Section of morula of rabbit, showing grouping of cells into central mass and peripheral layer. (Van Beneden.)

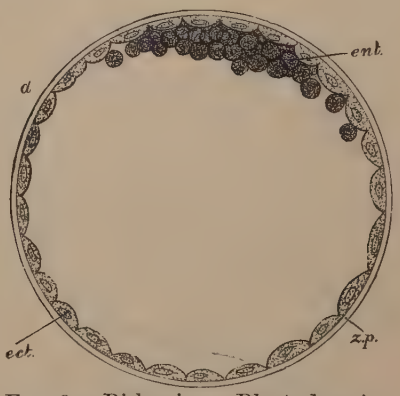


FIG. 9.—Bi-laminar Blastodermic Vesicle of Rabbit. (Van Beneden.)

ect. primitive ectoderm. *ent.* embryonic cell mass. *zp.* Zona pellucida.

cells becomes split off, known as the *entoderm ;* these cells speedily form a small cavity, the *endodermic cavity* or future *yolk sac*. A cleavage next appears in the cells of the embryonic cell mass, forming a cavity, the *amnio-embryonic cavity ;* the cells forming the floor of this cavity arrange themselves in a columnar manner and form a plate, which is the *embryonic ectoderm* (not to be confused with the *primitive ectoderm*) (Fig. 10). The cavity itself becomes the future *amniotic cavity*, which is thus closed from the first. The *mesoderm* is the last of the germinal layers to appear ; it buds off from the neighbourhood of the amnio-embryonic cavity as a loose layer of branched cells which spread widely, at first filling the entire space between the embryonic cell mass and the trophoblast, but later becoming concentrated into a lining layer to the trophoblast and a covering layer to the amnio-embryonic cavity and the yolk sac. The

mesoderm also insinuates itself between the trophoblast and the roof of the amnio-embryonic cavity, completely separating them by a layer from which the ventral stalk is formed later. We have now reached the stage at which the ovum is comparable to the early human ova described by Bryce and Teacher, Peters, and von Spee, and from this point can proceed upon the results of direct observation on the human ovum.

The ovum described by Bryce and Teacher was from a case of complete abortion, and is shown in its containing strip of

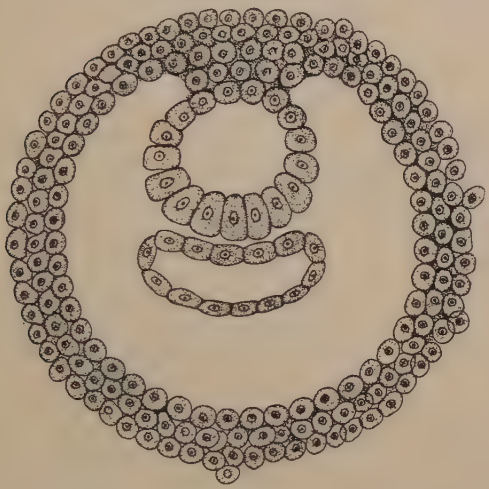


FIG. 10.—Hypothetical stage of human blastocyst, showing formation of amnio-embryonic and entodermic cavities. (T. H. Bryce.)

FIG. 11.—Bryce-Teacher Ovum (fourteen days) with the portion of decidua in which it was imbedded. The prominent oval lobule is the site of implantation. (Bryce and Teacher.)

decidua in Fig. 11. Circumstances were unusually favourable for the determination of the date of conception, and according to the authors the period of development may authoritatively be placed at about fourteen days, the limits of probability being twelve to fifteen days. Before the description of this specimen, an ovum described by Peters was believed to be the earliest, and this was estimated by him at three to four days' development only. But the Bryce-Teacher ovum is obviously an earlier stage than the Peters ovum, and it is certain that the period of development of the latter has been greatly underestimated; this is accounted for in part by the absence, in

Peters' case, of exact clinical data, the specimen being a post-mortem one from a case of suicide.

The general structure of the Bryce-Teacher ovum is diagrammatically represented in Fig. 12, and that of Peters in Fig. 13; both correspond to a stage considerably further advanced than the blastocyst shown in Fig. 9. The cells of the primitive ectoderm (the trophoblast) have proliferated and now form a reticulated layer; the mesoderm forms a solid mass of cells filling the central part of the ovum and surrounding and separating the entodermic and amniotic vesicles which lie side by side near the centre of the ovum (Fig. 12). In Peters' ovum

FIG. 12.—Diagram of the Bryce-Teacher Ovum (fourteen days). The cavity of the blastocyst is completely filled with mesoblast cells, and imbedded therein are the amniotic and entodermic vesicles. P.e., point of entrance; cyt., cyto-trophoblast; pl., plasmodi-trophoblast; n.z., necrotic zone of decidua; gl., gland; cap., capillary; pl¹., masses of plasmodium invading capillaries. (Bryce and Teacher.)

the mesoderm has split into two layers, the outer going with the trophoblast to form the chorion, the inner going with the amnion and the entodermic vesicle (Fig. 13). The relation of the blastocyst to the maternal tissues at this stage is a point of the greatest importance, and the observations of Hubrecht (comparative), of Peters, and of Bryce and Teacher permit of a fairly clear account being now given of what obtains in the human ovum.

Imbedding.—The ovum of Bryce and Teacher, and that of

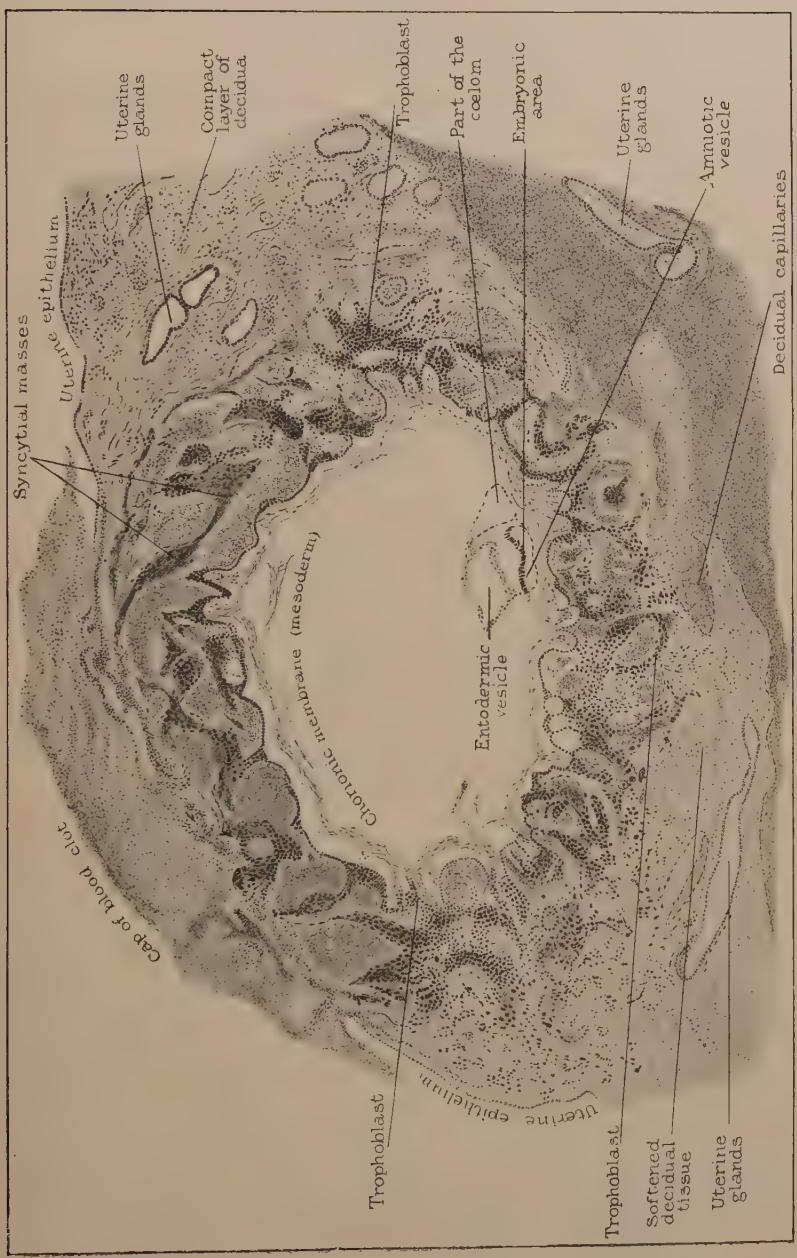


Fig. 13.—Peters's Ovum *in situ*.

Peters, were both found to be completely imbedded in the decidua (Figs. 12 and 13). The point of penetration is represented in the former by a minute depression of the surface where the epithelium is lost, and a small area of blood-clot is seen ; in the latter it is represented by a cap of fibrin of considerably larger size. How did the ovum penetrate the decidua and bury itself completely in this way ? The cells of the trophoblast are capable of exerting a destructive action upon the maternal tissues, and thus a bed is excavated in which the ovum lies and within which it further develops. After imbedding, the trophoblast shows extraordinary proliferative activity, while the other parts of the blastocyst remain almost

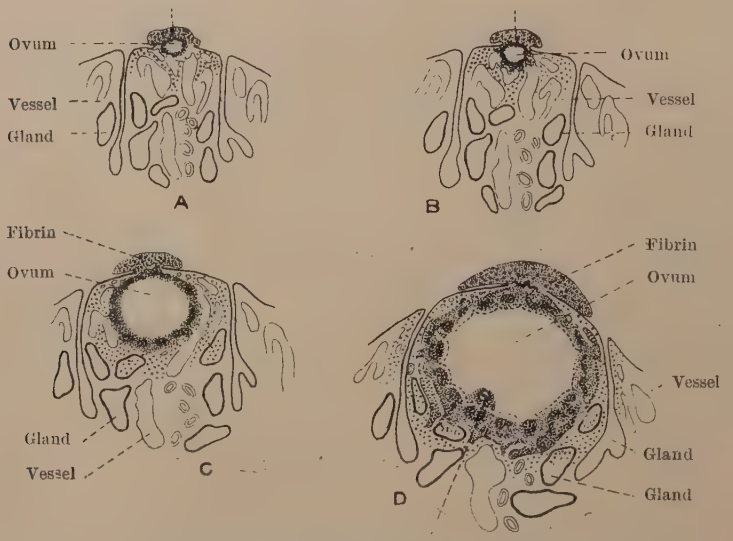


FIG. 14.—Imbedding of the Human Ovum. (Diagrammatic, after Peters.)

quiescent. Not only does the trophoblast area enlarge rapidly, but in it rapid cell-multiplication also occurs, forming a thick stratified layer. In both the Bryce-Teacher and Peters ova the trophoblast is differentiated into two parts, one which consists of nucleated protoplasmic buds, bands, and reticula in which no cell outlines can be distinguished—the *plasmodi-trophoblast* or *syncytium*, and one which consists of definite cells—the *cyto-trophoblast*. The plasmodial bands are arranged around the blastocyst in the form of a widely spreading network, into the spaces of which pass columns of the cells of the cyto-trophoblast ; in the meshes which, of course, form an inter-communicating system, a quantity of maternal blood is also to be found. The protoplasm of the plasmodi-trophoblast

is minutely vacuolated, and by fusion of adjacent vacuoles large spaces are formed in the plasmodia, many of which are seen to contain maternal blood. The space occupied by the trophoblastic network has been excavated in the decidual membrane, and the steps by which the excavation is carried out are shown diagrammatically in Fig. 14. It is believed that this effect is produced by a solvent or digestive action exerted upon the maternal cells by a proteolytic ferment produced by the trophoblast. As will be seen later on, the maternal tissues in contact with the ovum show evidence of a protective reaction,

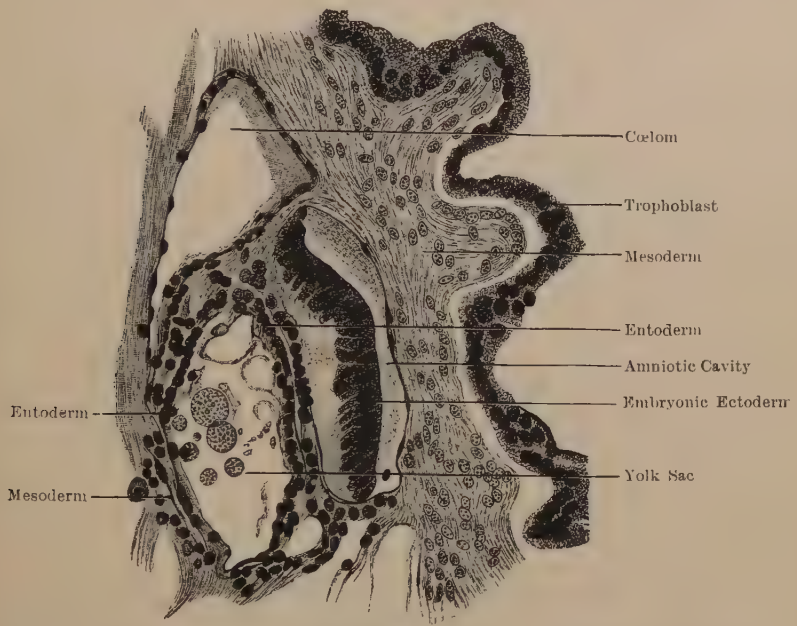


FIG. 15.—Embryonic Area in Peters's Ovum. (Galabin and Blacker.)

the object of which appears to be to defend themselves against these encroachments.

At the periphery of the trophoblastic zone are to be seen large maternal capillaries which have been penetrated by plasmodia ; the latter appear to have destroyed the endothelium and to have then entered into the lumen of the vessel. This process explains the presence of maternal blood in the spaces of the plasmodial network. This blood does not coagulate, and there is no doubt that it serves to nourish the embryonic structures. After a time the blood begins to circulate through the meshes, although at the beginning of the process it is necessarily stagnant. In this way we see that the nutrition of the ovum from maternal sources is provided for at a very

early period of development. The existence of such an arrangement as this in the mammalian ovum was first described by Hubrecht in the hedgehog, and the observations of Bryce and Teacher have demonstrated the occurrence of a precisely similar process in man.

It will be apparent that at this stage the development of the body of the embryo has hardly begun. A section through the embryonic area of Peters's ovum (Fig. 15) shows that the embryonic ectoderm is still merely a thick plate of cells on the floor of the amniotic vesicle, subjacent to which are the cells of the entodermic vesicle, with a thin intervening layer of

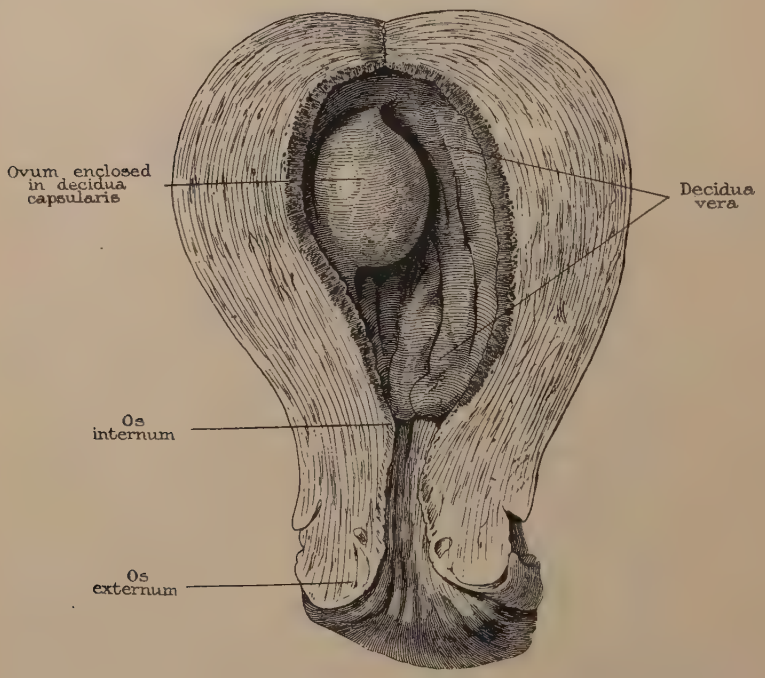


FIG. 16.—Uterus with Ovum of Four Weeks' Gestation. Natural Size. (Bumm.)

mesoderm. The amniotic and entodermic vesicles are connected with the trophoblast by a broad area of mesoderm, which in Spee's ova has been defined into the ventral stalk (Figs. 20 and 21), the precursor of the umbilical cord. The entodermic vesicle corresponds with the yolk sac, a structure of great importance in the development of birds and reptiles, since it contains a store of nutriment upon which the growing ovum draws. In mammals generally, and especially in man, this

structure is unimportant at the present stage, and has little if any nutritive function.

It will now be necessary to consider the maternal structures in which the ovum has found a lodgment.

The Decidua.—Under the stimulus of the implantation of

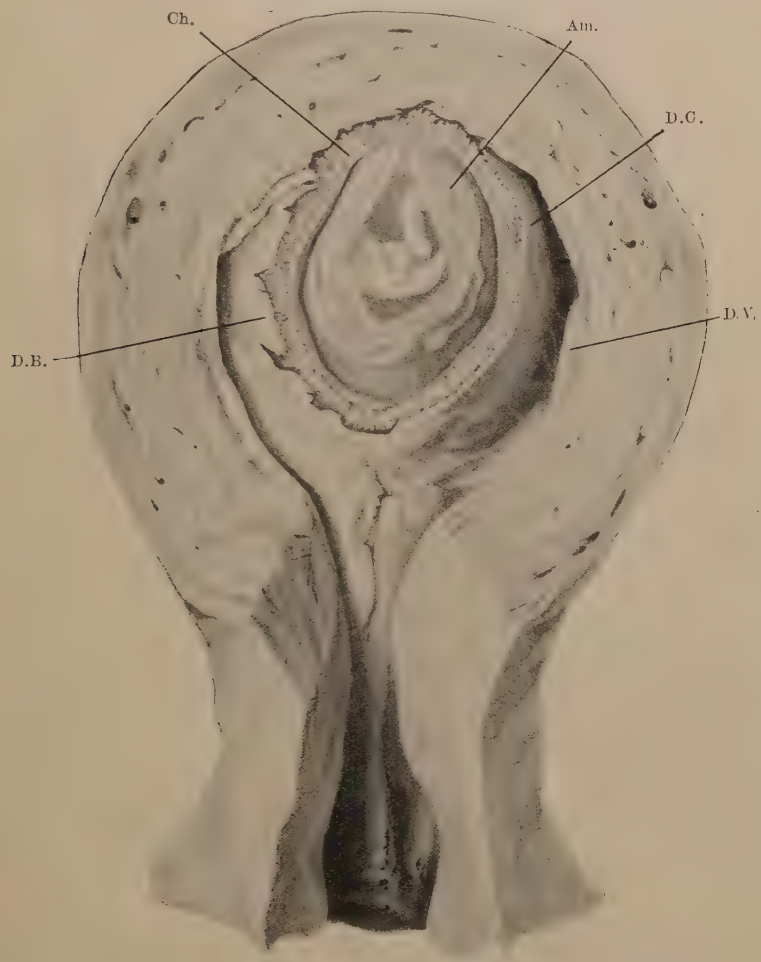


FIG. 17.—Uterus with Ovum of about Ten Weeks' Gestation. (Galabin and Blacker.)

the fertilised ovum in the uterus, the endometrium of the whole body of the organ becomes converted into the decidua. In a few cases definite decidual formation has been observed in the cervix. The decidual reaction, as it is called, begins in the area of endometrium on which the ovum is implanted and

quickly spreads until the whole endometrium is changed. As the ovum enlarges, it becomes possible to speak of three distinct portions of the decidua : (1) a large extent of the endometrium which is not in direct contact with the ovum at all, called the *decidua vera* (D.V.) ; (2) a portion in contact with the base of the ovum, called the *decidua basalis* (D.B.) ; and (3) a portion enclosing the remainder of the ovum, termed the *decidua capsularis* or *reflexa* (D.C.) (Fig. 17). The term 'decidua

FIG. 18. Decidua Vera ; Compact Layer. To the right of the figure the decidual cells are closely packed and polygonal ; to the left they are looser, and oval or globular.

reflexa ' indicates an old view of the formation of this portion of the membrane, which was that the ovum attached itself to the *surface* of the decidua, and later on became enclosed by the growth of a ring of decidual tissue around it, which, ultimately meeting over the free pole of the ovum, completely enveloped it. We now know that no such process occurs ; the ovum is imbedded in the decidua from the outset ; decidua and ovum develop *pari passu* in this position, thus preserving the original relation ; and ' decidua capsularis ' is therefore a better term than ' decidua reflexa.' The decidua basalis is the area upon

which the placenta is subsequently formed in the great majority of instances, although exceptions occur which will be referred to later on. We are unacquainted with the functions of the decidua vera.

All parts of the decidua have the same general structure, and, as has been already noted, the membrane bears a certain resemblance to the menstruating endometrium. The principal gross change which has occurred is the differentiation of the

FIG. 19.—Decidua Vera: Cavernous Layer.

decidua into two layers, the superficial *compact* and deep *cavernous* layers. The latter rests directly upon the uterine muscle. The deep layer is rendered cavernous by very marked, active dilatation of the deep portions of the uterine glands which form spaces of varied size and shape, with an epithelial lining showing evidences of active cell proliferation (Fig. 19). The superficial layer consists of a compact mass of 'decidual cells' in which appear here and there dilated capillaries—the 'decidual sinuses' (Fig. 18). The greater part of the surface epithelium is lost, and very few glands can be seen in this layer.

Where chorionic villi come in contact with the decidua certain striking structural changes occur which will be referred to later on. The cavernous layer is well marked in the decidua basalis, but is not nearly so well differentiated in the other parts of the decidua. The ' decidual cells ' are specialised connective-tissue cells ; in most situations they are closely packed together and become polygonal from pressure ; where the arrangement is looser they assume a spherical or oval shape. Their nuclei are large and globular. Among the decidual cells are seen numerous small interstitial hæmorrhages, and here and there some leucocytic infiltration (Fig. 18). The differences between the decidua and the normal endometrium may be briefly summed up as follows : (1) formation of decidual cells ; (2) hypertrophy and dilatation of the deepest portions of the glands ; (3) increased vascularity, leading to formation of widely dilated capillaries or ' sinuses,' and interstitial hæmorrhages ; (4) exten-

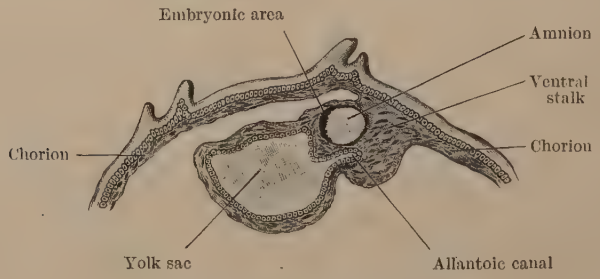


Fig. 20.—Spee's Human Ovum from early part of third week. (Galabin and Blacker.)

sive loss of the surface epithelium ; (5) division into two layers—the superficial compact, the deep cavernous ; (6) great increase in thickness—endometrium about $\frac{1}{25}$ of an inch, decidua $\frac{3}{4}$ to $\frac{7}{8}$ of an inch.

The decidua vera increases progressively in thickness until it attains its maximum at about the end of the second month. By the end of the third month the decidua capsularis and decidua vera have been brought into apposition with each other by the rapid increase which has taken place in the size of the ovum. It appears probable that during the early months the decidua exercises a certain protective function towards the maternal organism. It arrests the invasion of the trophoblast, and the active cellular reaction which occurs later on wherever chorionic villi meet it (*vide infra*) is probably to be understood as a protective reaction. The main function of the decidua, however, is to afford a nidus in which the ovum may be imbedded and thus protected against traumatism, which the delicacy of its structures renders it specially prone to suffer

from. During the fourth month these two layers become fused, and at term they have become extensively atrophied from pressure so as to be indistinguishable as a double layer. The decidua basalis becomes the maternal portion of the placenta, but conserves its characteristic appearances in the cavernous layer till term.

Chorion and Placenta

We have now followed the steps which have been demon-

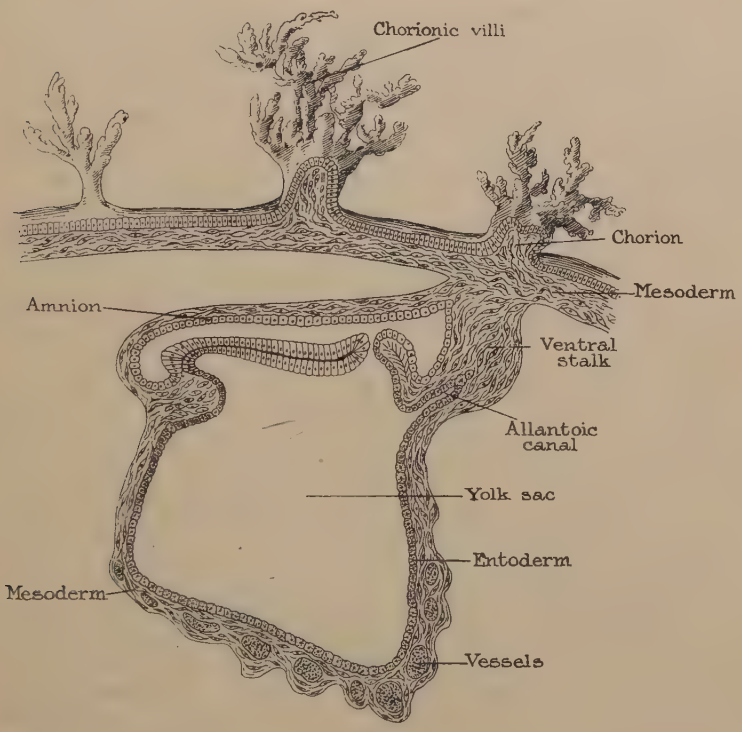


Fig. 21.—Sagittal Section of Spee's Ovum : a little more advanced than Fig. 20. (Graf Spee.)

strated in the imbedding of the fertilised ovum in the decidua, and in the formation of the trophoblast. These arrangements provide for the nutrition of the ovum at this early stage by bringing its outer covering into direct contact with free maternal blood. The next stage is the formation of the chorion or specialised outer fœtal envelope. The transformation of the trophoblast into the chorion is brought about by the formation of villi which replace the irregular network of plasmodial cells and processes of which the former consists. The beginning

of this stage is represented in Spee's ova shown in Figs. 20 and 21. The general relations of the various parts of the blastocyst are here the same as in the ova of Bryce-Teacher and Peters, but two points of progress are apparent. Firstly, the outer envelope is beset with branching processes or villi, consisting of an outer epiblastic covering, and an inner mesoblastic core of connective tissue which soon becomes highly vascularised. Secondly, the embryonic area with its amniotic and entodermic

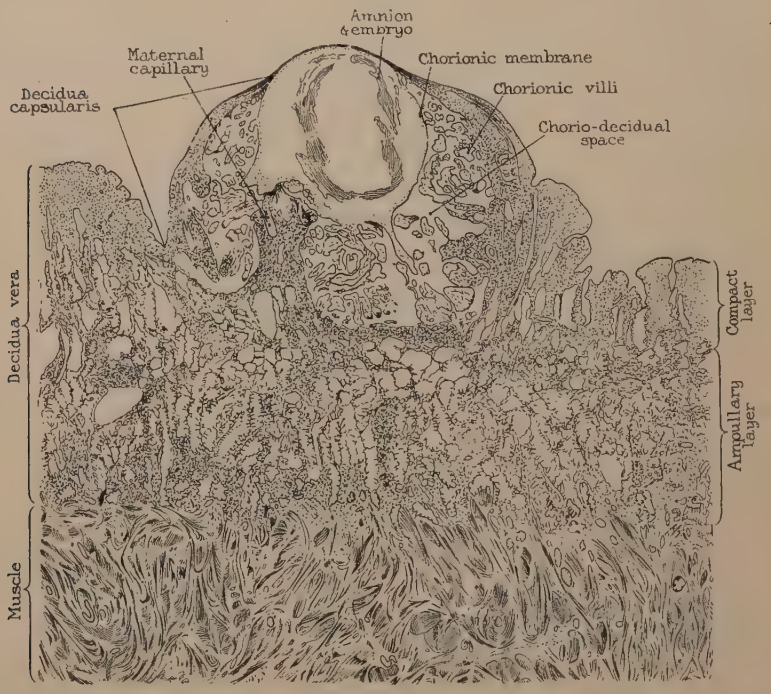


FIG. 22.—Leopold's Ovum (twelve to eighteen days) *in situ*. (Leopold.)

vesicles is connected with the outer envelope by a mesoblastic process which is the precursor of the umbilical cord; it is known as the *abdominal pedicle* or *ventral stalk*, since it comes, at a later stage, to be attached to the ventral surface of the body of the embryo. The relatively small size of the amnion is well shown, and it will be observed that the arrangement closely resembles the diagrammatic representation of the development of the amnion shown in Fig. 12.

The relations of the chorion to the decidua must now receive attention, and it will become evident that important develop-

ments have occurred in the relation of the embryonic and maternal structures to each other.

These relations can best be seen, however, in another ovum of a somewhat later period—that of Leopold, shown in Fig. 22. This ovum, which was examined *in situ*, is estimated to be about seventeen to eighteen days old. The manner in which the relations of the ovum to the decidua are developed has been shown diagrammatically in Fig. 14.

In Leopold's ovum it is apparent that the decidua and the chorion are separated by a considerable space except at the two poles ; at the base a process of the decidua basalis directly supports it ; at the free pole chorion and decidua are united over quite a considerable area, corresponding to the position of the fibrin cap in Peters's ovum. The space between chorion and decidua is termed the *chorio-decidual space*, and is occupied by numerous villi, seen in section in the figure, most of which contain blood-vessels. Some are free, some are attached to the decidua by their tips ; in the spaces between them lies fresh maternal blood, and one or two delicate maternal capillaries can be seen opening into the chorio-decidual space. The chorio-decidual space represents the area over which decidual tissue has been destroyed by the trophoblast ; the chorionic villi have replaced the irregular network of plasmodial processes and cellular columns which constituted the trophoblast ; and further the villi have become vascularised by the ingrowth of blood-vessels from the growing embryo. This is obviously a great advance towards the formation of a placenta with a double, *i.e.* fœtal and maternal, circulation. In a second, somewhat older ovum, Leopold found that the whole surface of the chorion was beset with villi, the chorio-decidual space being continuous around the entire ovum. The arrangement corresponds, in fact, to a simple form of diffused placenta surrounding the whole ovum, and shows a distinct advance in construction upon the trophoblast previously described ; nutritive materials from the effused maternal blood can be taken up by diffusion into the fœtal circulation. In this manner the nutrition of the ovum is carried on, while time is gained for the formation and growth of the highly complex discoidal placenta. It is not until the end of the sixth week that this placenta begins definitely to be formed, so that the chorio-decidual space plays an important part in the nutrition of the ovum for a considerable period, from the third to the sixth week.

The structure of the chorion during the first six weeks of development must now be more fully described. The chorion at this period is everywhere covered with complex branching villi. In their earliest form the villi are short, thick columns which subdivide in a digitate manner (Fig. 21). Later on they

become complex, arborescent structures, the main divisions of which contain large vessels; only the terminal and subterminal branches are then called villi. These, however, constitute the great bulk of the developed chorion and are definitely arranged in clusters, foreshadowing the placental lobes, in an ovum of about six weeks' development (Fig. 23), and form a thick layer of delicate branching processes springing from the outer surface of the chorion, which in places can be seen as a

FIG. 23.—Complete Ovum, 3·5 × 4·25 cm., about the sixth week of development. The chorion is beset with villi which are arranged in clusters. The dark area in the upper part is blood-clot. (Charing Cross Hospital Museum.)

smooth membrane. The chorion consists of three main elements: (1) an epithelial covering; (2) a connective tissue stroma; (3) a system of blood-vessels.

(1) The chorionic epithelium is the outer covering. It consists of two distinct layers—an *outer* layer of multinucleated protoplasm, undifferentiated into cells; and an *inner* layer of large well-defined cells with oval nuclei, frequently resting upon a distinct basement membrane (Fig. 25). These layers are respectively derived from the plasmodi-trophoblast and cyto-trophoblast previously described in connection with the im-

bedding of the blastocyst. The outer layer is termed the *syncytium*, or simply the *plasmodial layer ;* the inner is termed the *cellular layer*, or, after its discoverer, the *layer of Langhans*. Both layers are derived from the primitive ectoderm of the blastocyst. During the first two months of development the chorionic epithelium displays great proliferative activity, both layers participating, but especially the syncytium. The latter

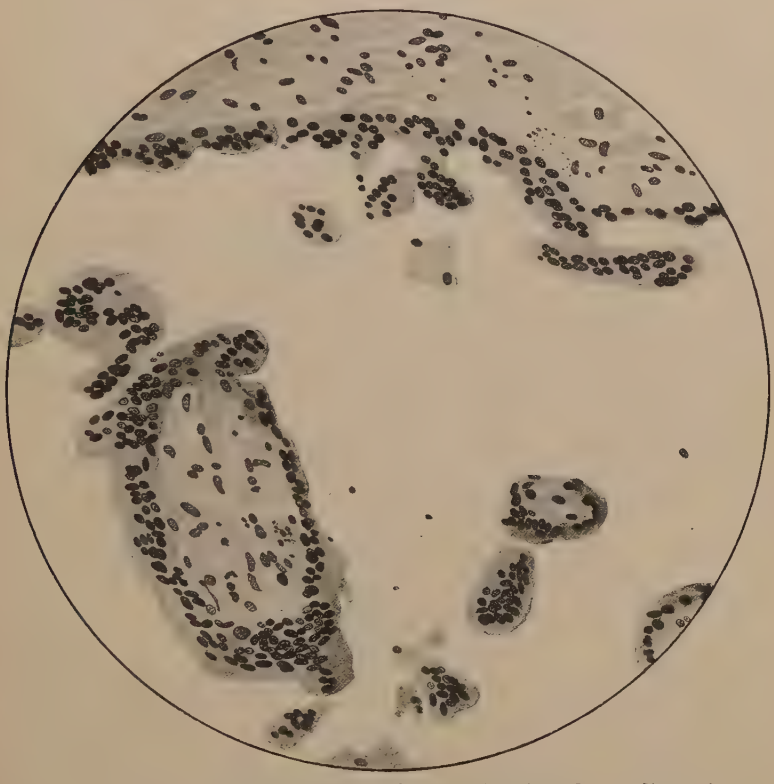


FIG. 24.—Villi from a six weeks' Ovum, showing the proliferation of the syncytium (low power).

structure throws out enormous numbers of plasmodial buds and processes in the form of knobs, club-shaped outgrowths, or slender elongated bands ; in a microscopic section many of these buds are seen cut across in transverse section and appear as independent areas or islets of nucleated plasmodium (Fig. 24). The cells of the inner layer also proliferate actively, especially at the sides and tips of the villi ; they appear as clusters of cells usually covered with a thin layer of plasmodium. These also may be seen cut across in transverse section, and are dis-

tinguished as the 'islets of Langhans.' A characteristic feature of the young syncytium is extensive vacuolation; it will be recollected that this is also to be observed in the original trophoblast. The chorionic epithelium retains the characters just described until the second half of pregnancy, when changes in its structure occur which will be referred to later on (p. 41).

The syncytium contains a large amount of glycogen and finely divided fat, the function of which is not clearly understood.

(2) The stroma is a delicate reticulum of connective tissue,

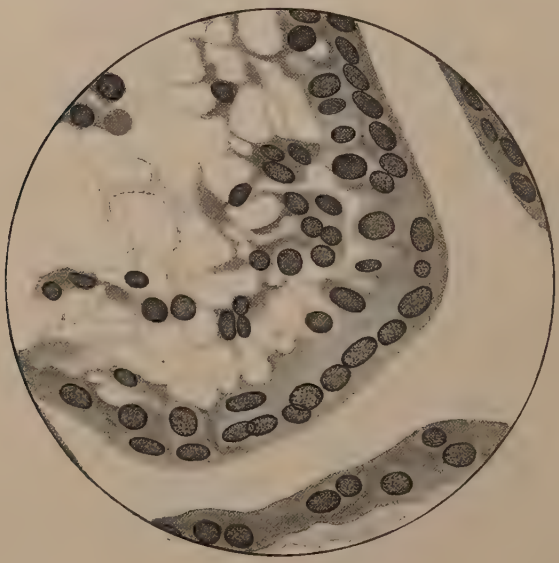


FIG. 25.—Edge of a Villus from the same specimen as Fig. 24, showing the double layer of cells of which the epithelium consists (high power).

embryonic in type, which supports the blood-vessels; in the larger chorionic branches it is more compact than in the terminal branches or villi. The interstices form a system of anastomosing channels which are probably of the nature of lymphatics.

(3) The blood-vessels are the terminal ramifications of the umbilical arteries and veins; in the larger chorionic branches they lie in the axis; in the terminal villi capillaries only are found, and these lie immediately beneath the epithelium, where they run a tortuous course and anastomose freely. In an injected placenta, a tiny thread of colouring-matter can often be traced from a villus into one of its syncytial buds, showing

the beginning of vascularisation. The fully developed villi are extremely vascular, and often appear under the microscope to be as full of blood as a soaked sponge (see Fig. 26); between the fœtal blood in the villi and the maternal blood in the chorio-decidual space nothing intervenes except the

Fig. 26. — Fully formed Villus from a Placenta at term, showing wide capillaries. It will be noted also that the epithelial covering is atrophied and incomplete.

chorionic epithelium and the endothelium of the fœtal capillary wall.

The chorion and the chorio-decidual relations undergo no marked change until the latter half of the second month, when the formation of the discoidal placenta is begun. The process simply consists in the specialisation of a part of the chorion to perform the work previously done by the whole. At the placental site—the base of the ovum, the villi increase greatly in size, number, and complexity, while important changes also occur in the underlying decidua. Over the remainder of the chorion the villi become devascularised and undergo atrophy

early in the third month, converting this portion into a smooth membrane. The placental chorion is termed the *chorion frondosum;* to the atrophied extraplacental chorion the name *chorion lævе* is applied (Figs. 27 and 28). Chorion læve and decidua capsularis are not united by intergrowth as are chorion frondosum and decidua basalis.

The changes which now occur at the placental site lead up to three important results: (1) by repeated subdivision enormous numbers of chorionic stems and terminal divisions (villi) are produced; (2) firm attachments are formed between the fœtal and maternal elements; (3) a definite maternal circula-

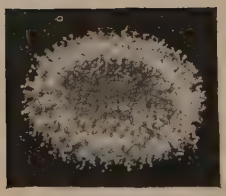


Fig. 27.—Ovum at fourth week, completely covered with villi.

Fig. 28.—Ovum at ninth week, showing chorion frondosum and chorion læve.

tion is established through that portion of the chorio-decidual space which is in relation to the decidua basalis.

(1) The *enormous numbers of villi* present in the placenta will be understood from an examination of Fig. 31, which represents a vertical section through the entire placenta. The larger chorionic stems spring from the chorionic membrane underlying the amnion, and, dividing irregularly, terminate in an indefinite number of small divisions termed villi. Some of these stems traverse the whole thickness of the placenta, so that their terminal villi reach the decidua basalis. Both villi and larger branches appear in sections to be of diverse size and shape (Fig. 29), but this is partly due to the varying angles at which they have been cut. The larger branches all contain large vessels, and through the centre of the largest of all one or

more arteries and veins, running side by side, can usually be traced. The villi are not in contact with one another, but are separated by spaces—the intervillous spaces. It will be obvious that these spaces form throughout the placenta an elaborate system of branching channels allowing free communication to take place between one part of the organ and another, Through the general system of intervillous spaces the maternal

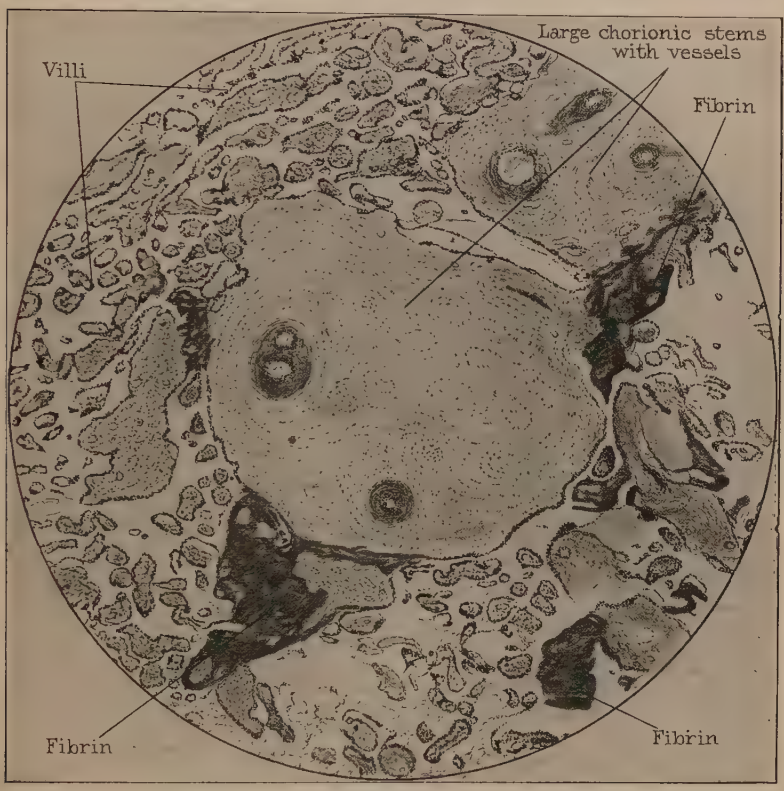


FIG. 29.—Fully developed Placenta of the eighth month. In the larger stem is an artery, in section, with the lumen narrowed by endarteritis.

circulation is carried on, so that a gentle stream of maternal blood is perpetually flowing around the villi. When the large numbers of these villi are borne in mind, it will be evident that the superficial area of contact between the fœtal structures and the maternal blood in the placenta is of very great extent. In many places adjacent villi become united to one another by small deposits of fibrin ; isolated syncytial masses are seen here and there, and in places clusters of nuclei, representing

areas of proliferating Langhans' cells, can be seen on the surface of a villus or free in the intervillous spaces (islets of Langhans). A good deal of maternal blood can be found in the intervillous spaces, when care is taken to prevent it from escaping during the preparation of the tissue for microscopic section.

(2) The *placental attachments* consist of (*a*) a firm union

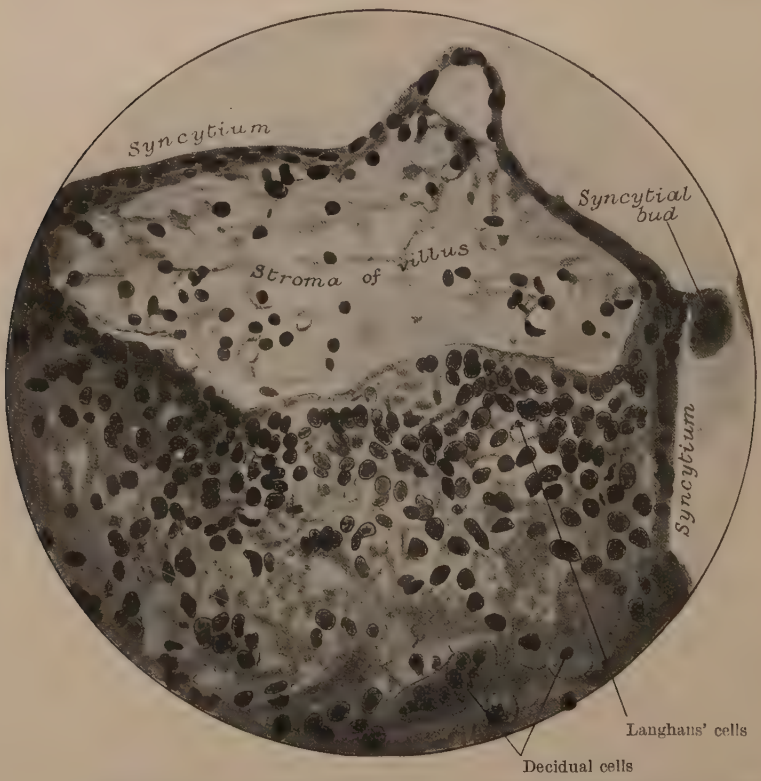


FIG. 30.—Placental Villus attached to the Decidua. The proliferating cells of Langhans' layer have invaded the decidual tissues.

between large numbers of villi and the surface of the decidua basalis, and (*b*) a special development of the decidua at the margins of the organ. (*a*) The attachment of the villi to the decidua presents some interesting features. Where the two come into contact, the syncytial layer of the chorionic epithelium disappears, and a marked proliferation of the cells of Langhans occurs; these cells spread out over the adjacent surface of the decidua for some distance, and also penetrate it to some extent, lying among the decidual cells proper (Fig. 30). In this way the villus and the decidua become firmly welded together by a vital process of growth. Many villi can be found

deeply imbedded in this manner ; others are attached merely by their tips. (*b*) At the placental margin where the three

FIG. 31.—Section through a Seven Months' Placenta *in situ*. (Minot.)

parts of the decidua are united, the membrane is of great thickness and strength ; from this thickened portion a process can be traced running inwards for a distance of 1 to 2 inches beneath the chorionic membrane (Fig. 32), thus adding greatly

to the area and strength of the union between maternal and fœtal structures. This portion is termed the *sub-chorionic decidua ;* it will be seen that it limits circumferentially the general system of the intervillous spaces.

(3) *The development of the maternal circulation* through the placenta has not yet been traced in detail ; great controversy has raged in the past upon the origin of the intervillous spaces, into which we need not enter, as this controversy is now dead. The ova of Peters and Leopold show us the beginnings of these spaces, and no great stretch of the imagination is required to carry the student from the reticulated trophoblast of the second week to the chorio-decidual space of the third, and from the latter to the intervillous spaces of the placenta itself. The

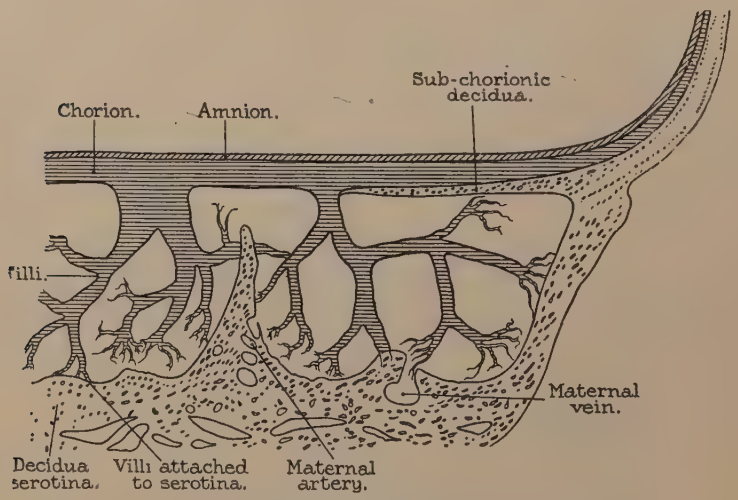


FIG. 32.—Scheme of the Placental Attachments.

intervillous spaces are, of course, progressively developed from the meshes of the trophoblast. In an ovum of two weeks' development small mesoblastic processes may be seen penetrating the trophoblast buds for a short distance. Later on these buds may be seen to have increased greatly in length ; later still they become branches, and are then vascularised by vessels which grow into them from the chorion. These are fully formed chorionic villi ; they are separated from one another by a system of inter-communicating spaces which are the direct derivatives of the meshes of the trophoblast. During the development and growth of the placenta large maternal vessels become laid open, so as to communicate with these spaces, and the active agents in the production of this important change are the chorionic villi. The destructive influence

exerted upon maternal tissues by the young chorionic epithelium has been referred to ; evidences of penetration of the walls of maternal vessels by syncytial buds and processes are abundant in the developing placenta, where all stages of the process may be traced in tissue cut into serial sections. The vessels thus penetrated are probably merely the dilated capillaries or 'sinuses,' which have been described as occurring in

FIG. 33.—Section through the Membranes near the placental margin, The atrophied villi show remains of their epithelial covering.

the endometrium of menstruation and in the decidua—*i.e.* they are vessels the walls of which consist merely of an endothelial coat, and which therefore offer but a feeble resistance to the proteolytic action of the chorionic epithelium. After having been thus laid open they lose their endothelial lining. It is often difficult to distinguish afferent from efferent maternal channels, since both arise from dilated capillaries. A minor result of proteolytic action is that the surface of the decidua

basalis becomes irregularly excavated and presents a series of elevations and depressions. Where villi are not in actual contact with the decidua a thick layer of fibrin is deposited upon it from the maternal blood. Many maternal vessels can be seen opening into the intervillous spaces on the floor of the decidua (Fig. 31). The maternal circulation through the placenta is probably slow. Towards the middle of pregnancy the sub-placental sinuses assume very large proportions, and their closure after the placenta has been shed is a matter of vital importance to the life of the mother.

As these changes progress the chorio-decidual space outside the placental area becomes obliterated by the pressure of the growing ovum; atrophied villi surrounded by deposits of fibrin may always be found in the membranes at term if looked for under a microscope (Fig. 33). The placental area grows very rapidly during the first few weeks of its formation, until at the end of the third month, when the ovum fills the uterine cavity, it occupies about one-fourth to one-fifth of the total area of the surface of the uterine walls. Afterwards it grows *pari passu* with the uterus, and the same proportion is preserved up to term.

When the ovum grows large enough to fill the uterine cavity completely—*i.e.*, about the end of the third month—the decidua capsularis becomes apposed to the decidua vera, and at term these two portions of the maternal membranes are inseparable. Up to the end of the third month a space exists in the uterine cavity below the ovum, bounded above by the decidua capsularis, laterally by the decidua vera, and below by the os internum; it is called the *decidual space* (Figs. 16 and 17). When the two portions of the decidua become apposed, the decidual space is obliterated. At term the decidua capsularis has undergone extensive atrophy from pressure, and the same change, but less advanced, is observed in the decidua vera. This is of importance in relation to the process of shedding the placenta.

Upon the maintenance of the relations just described between the fœtal and maternal elements of the placenta the nutrition of the fœtus *in utero* entirely depends. After the formation of the firm chorio-decidual attachments, accidental separation of the two is not so readily brought about as at earlier periods; hence the diminished liability to abortion after the third month.

Functions of the Placenta.*—The placenta performs for the fœtus the functions of respiration, food absorption, and excretion. Waste products are carried to the terminal villi, and are thence passed out into the maternal blood-stream; food substances and oxygen pass in the opposite direction. The

* In this section, as well as in the sections on "the physiology of the fœtus" and "the general physiology of pregnancy," the authors have extensively consulted Dr. Marshall's well-known book, "The Physiology of Reproduction."

enormous surface area presented by the myriad villi to the slowly circulating maternal blood in the intervillous spaces is beautifully adapted to the process of interchange of substances between the mother and the fœtus. There is, of course, no direct communication between the fœtal blood in the chorionic villi and the maternal blood in the intervillous spaces, but the two come into very close proximity. Throughout the first half of pregnancy the trophoblast remains well developed, and the two blood-streams are separated by the double-layered chorionic epithelium, by a layer of stroma, and by the fœtal capillary-wall. During the last half of pregnancy the trophoblast gradually degenerates; the layer of Langhans completely disappears, the syncytium becomes an incomplete attenuated membrane no thicker than an endothelium, and the distended fœtal capillaries almost fill the villi. Consequently, the two blood-streams become separated by a thin compound membrane composed of a patchy layer of atrophied syncytium, a mere film of stroma, and the endothelium of the fœtal capillaries. Such a membrane is comparable with a semi-permeable membrane through which the diffusion or dialysis of substances may occur under the influence of osmotic pressure.

In the early months of pregnancy, when the daily requirements of the embryo are small and the quality of the nutritive material is more essential than the quantity, the embryo receives its nourishment almost entirely through the agency of the trophoblast. At this stage the trophoblastic covering does not act merely by the physical laws of diffusion and osmosis; it possesses a physiological or "vital" action, which enables it not only to select substances, but to break them down further or to resynthesise them, as the case may be, into forms most suitable for the requirements of the growing embryo. Thus are the embryonic cells spared much of the work of the elaboration of food material, and can conserve their energies for their own multiplication and elaboration. The trophoblast possesses proteolytic, lipolytic, glycolytic and oxidising ferments to enable it to perform this function. The trophoblastic metabolism of proteins is indicated not only by the existence of an intracellular proteolytic ferment, but also by the presence of decomposition products of protein in the placenta. The absence of fat droplets in the superficial parts of the syncytium and its presence in the deeper parts suggests that fat is absorbed in the form of glycerine and fatty acids, and is resynthesised as it passes through the syncytium. Glycogen is not demonstrable in the trophoblast, but is abundant in the contiguous decidua, which suggests that the glycogen is transformed into glucose before absorption by the trophoblast.

During the last half of pregnancy the daily nutritive requirements of the fœtus are greater, but it is better able to deal

independently with nutritive material brought from the maternal blood. It is impossible to believe that the attenuated syncytium at this stage possesses any physiological activity; indeed the fact that the fœtus, when prematurely born, is able to maintain life without its aid suggests that it has none. The covering of the chorionic villi acts like a semi-permeable membrane, and the interchange of substances between mother and fœtus is brought about by the processes of diffusion and osmosis.

From comparative analysis of the fœtal blood flowing to and leaving the placenta, we know that it gives up carbonic acid and absorbs oxygen in transit. Amongst drugs and poisons which are known to pass through the placenta may be mentioned cyanide of potassium, bromide and iodide of potassium, the salts of arsenic, copper and lead, carbolic acid, sodium salicylate, quinine, morphia and atropine. Chloroform administered to the mother is transmitted in small quantities to the fœtus, and so is ether. In the treatment of maternal syphilis it is useful to know that the salts of mercury and arsenic will reach the fœtus with favourable effect. It is also of great practical importance to realise the effect on the fœtus of powerful hypnotic and analgesic drugs, such as morphia and hyoscine, given to the mother during labour; paralysis of the fœtal respiratory centre, resulting in prolonged but rarely fatal apnœa, commonly occurs if morphia is given shortly before the fœtus is born. The placenta contains a considerable amount of glycogen and fat; the glycogen is especially abundant in the decidual cells during the first half of pregnancy, and no doubt this storage of glycogen is used for the sugar requirements of the rapidly growing fœtus. Bacteria are able to pass through the placenta from the mother to the fœtus, but they seldom do, and there is no doubt that the placenta acts as a very effective protective barrier against the transmission of bacterial infections. It has been shown that the tubercle bacillus, the typhoid bacillus, the bacillus of diphtheria, anthrax and glanders, the pneumococcus, streptococcus and meningococcus may occasionally be transmitted. The transmission of typhoid fever, however, appears to be not uncommon. Infection of the fœtus with the tubercle bacillus is a great rarity. The occurrence of intra-uterine small-pox is well known, and one of the world's greatest obstetricians, Mauriceau, came into the world pock-marked. The malaria parasite is never transmitted to the fœtus. The outstanding example of *transplacental infection* is fœtal syphilis, which, together with other fœtal infections, will be considered in a later section.

The Placenta at Term.—When shed from its uterine attachments, the placenta is an oval or circular flat cake measuring 6 to 8 inches (15 to 20 cm.) in diameter, $\frac{3}{4}$ to 1 inch (2 to $2\frac{1}{2}$ cm.) in depth at the centre, which is the thickest part, and weighing

about sixteen ounces. The margin is thinner and firmer than the centre, and passes abruptly into the chorion læve. The *fœtal surface* is covered with a thin smooth membrane—the amnion, which can be readily stripped up to the insertion of

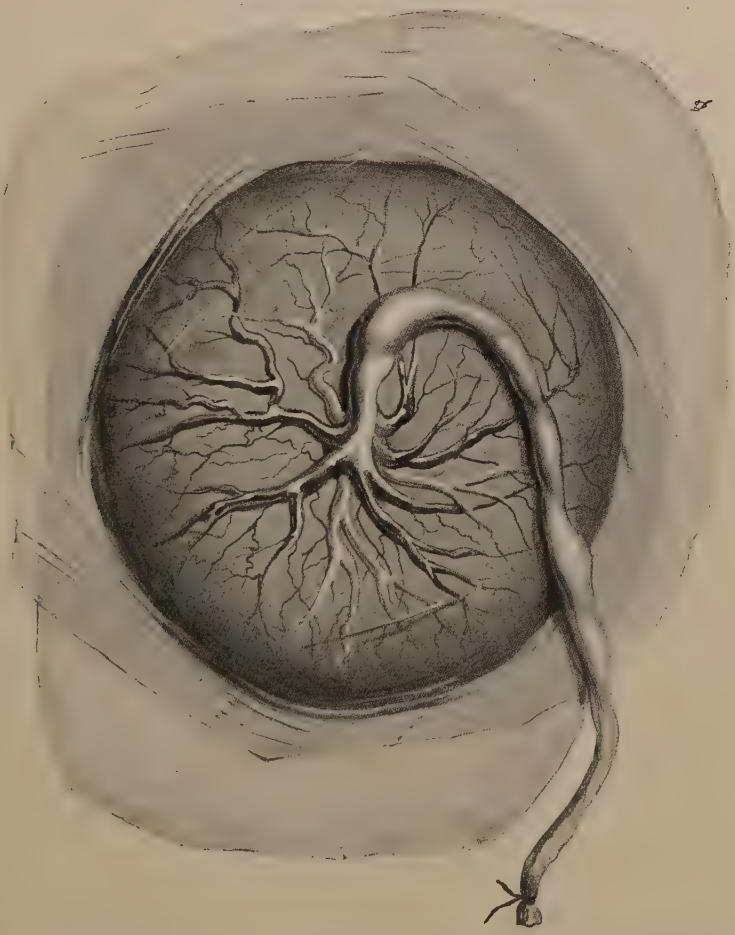


Fig. 34.—Human Placenta, fœtal surface; the inner thin membrane is the amnion, the outer thick one is the chorion.

the unbilical cord. The surface of the chorion thus exposed is also smooth in appearance, and running over it are seen the large superficial branches of the umbilical vessels. The arteries run irregularly outwards, but never quite reach the margin in a normal placenta (Fig. 34); the veins accompany and often cross them. If the fœtal surface is now incised, the chorionic

membrane is seen to be about $\frac{1}{12}$ inch in thickness, and from its deep surface springs the mass of spongy tissue representing the villi. The *uterine surface* (Fig. 35) contrasts strongly with this. It is of a dull red colour, and is divided by sulci into a number of irregularly quadrilateral areas termed the cotyledons. No vessels are visible upon it. On close inspection it can be seen to be covered with a thin greyish mottled membrane which represents the shed portion of the decidua basalis ; in

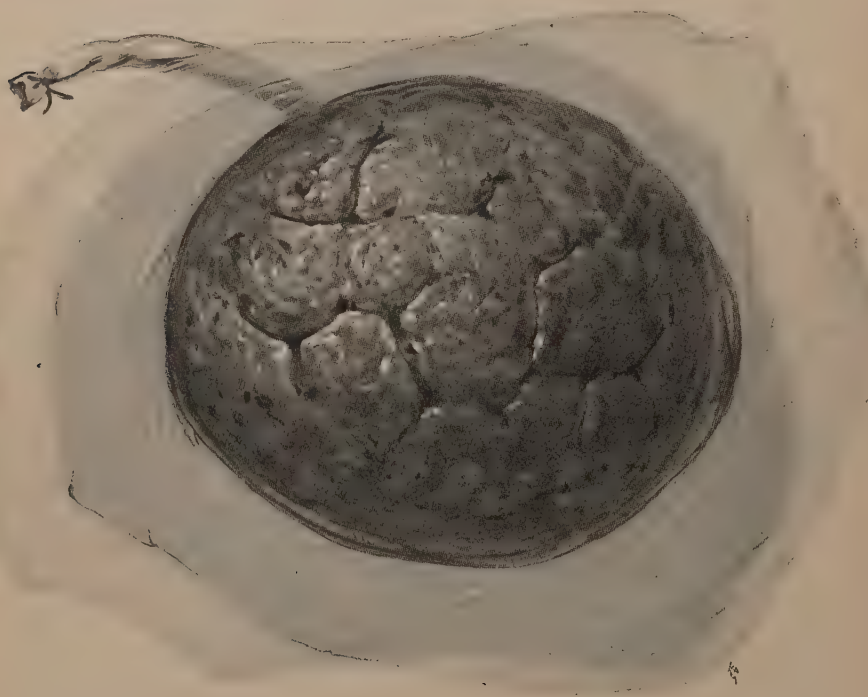


Fig. 35.—Human Placenta, uterine or maternal surface. The white patches are areas of calcareous degeneration.

parts this is incomplete, exposing the deep red spongy tissue beneath, and often it feels gritty to the touch from the presence of minute areas of calcareous degeneration. In some instances, areas of calcareous degeneration are found large enough to be visible to the naked eye ; these are generally found near the centre of the placenta. Around the margin runs a large venous channel called the *circular sinus*, which returns some of the maternal blood from the intervillous spaces ; it seldom completely surrounds the placenta. If the placenta is incised, a great deal of dark blood slowly runs away from it, and if a

stream of water is turned upon the cut surface the intervillous spaces will be washed out and the arborescent villi appear as a dense reticulum of greyish threads. The placenta is usually attached to the upper part of the body of the uterus, including the fundus, and, with about equal frequency, to the adjacent anterior or posterior wall.

Clear evidence of extensive degeneration is to be found in the placenta at term. It must be remembered that the placenta is a caducous structure which, after serving its temporary purpose, is cast off by the organism. Degeneration is the necessary preliminary of shedding, and merely indicates a progressive diminution of vitality towards the close of the period of its existence. These degenerative changes are chiefly of importance because of the necessity of distinguishing them from true morbid processes. Both the fœtal and maternal elements of the placenta are affected. The initial change consists in the occlusion of considerable tracts of the middle-sized divisions of the umbilical arteries by a process of obliterating endarteritis ; it may be found as early as the seventh month of pregnancy, and it slowly progresses. This causes a diminution in the blood supply of the villi fed by the affected arterioles, which results in their gradual atrophy and degeneration ; this again is accompanied by the extensive deposition of fibrin from the maternal blood upon the chorionic epithelium, so that the neighbouring villi meet and the intervillous spaces of the affected area thus become obliterated. In this manner solid patches are formed among the spongy placental tissues, in which the villi are functionless, for the fœtal circulation has been arrested by obliterating endarteritis, while the maternal circulation has been destroyed by blocking of the intervillous spaces with fibrin. These patches are termed *placental infarcts ;* they occur as firm yellowish-white well-defined areas, varying in size, under normal conditions, from that of a millet seed to that of a filbert. They are most numerous on the uterine surface and on the marginal cotyledons. The superficial layers of the decidua basalis undergo a form of coagulation necrosis, and upon the necrosed areas laminated deposits of fibrin from the maternal blood are formed. In addition, extensive thrombosis occurs in the sub-placental sinuses during the later months of pregnancy, the cause of which is not well understood, but which certainly interferes to some extent with the freedom of the maternal circulation.

From about the fifth month onwards the chorionic epithelium consists of only one layer—the syncytium ; the layer of Langhans has disappeared. The syncytium is also much less active in the later than in the earlier months, throwing out comparatively few buds and processes ; and as term approaches this layer becomes atrophied and incomplete (Fig. 26).

It is possible that these degenerative changes limit the duration of pregnancy, and participate in causing the onset of

FIG. 36.—Complete Ovum from the fourth or fifth week, magnified. The fœtus is closely invested by the amnion, and is attached by the ventral stalk to the wall of the chorionic vesicle. The amniotic sac is very small, and contains little fluid. (Quain's Anatomy.)

labour by rendering the placenta incapable of providing for the continually increasing nutritional requirements of the fœtus.

Amnion, Umbilical Cord, and Fœtus

Amnion.—This membrane consists of an outer layer of mesoderm and an inner layer of ectoderm. In the human ovum it is from the first a closed sac, and in the earliest ova it is seen to be very much smaller than the chorion and separated from

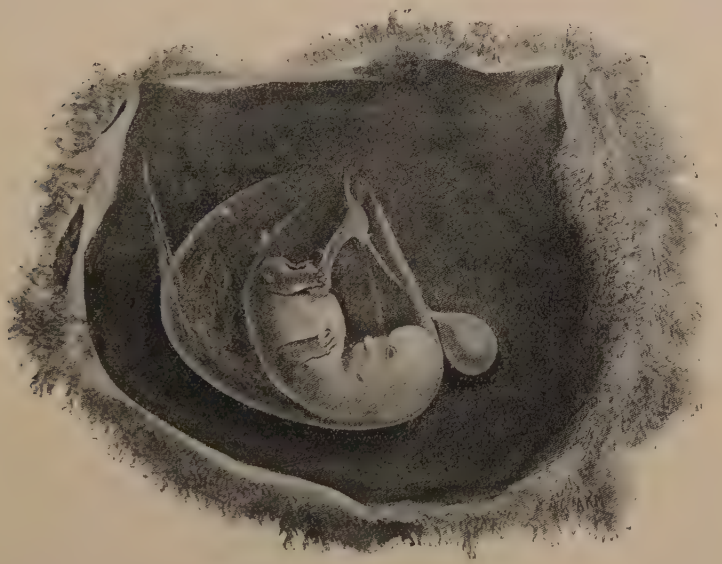


FIG. 37.—Complete Ovum from about the ninth week. Note the large size of the chorionic vesicle, and the relatively small size of the amniotic sac, which is full of fluid. (Quain's Anatomy.)

it by a considerable thickness of mesoblastic tissue (Fig. 20). These relative proportions are preserved for some weeks, and so slowly does the fluid accumulate in the amnion that it does not grow large enough to come into contact with the chorion until the third month (Figs. 36 and 37).

Until the body of the embryo has been clearly defined the amnion covers only its dorsal surface ; gradually, however, its line of origin advances over the ventral surface to converge upon the umbilical cord. Ultimately amnion and chorion come in loose contact by their mesoblastic surfaces, but no vital union takes place between them. The fully formed amnion consists of a single layer of cubical or low columnar epithelium resting upon a stratum of loose connective tissue. As pregnancy advances the epithelium becomes flatter. The amnion is firmly united to the umbilical cord at its point of insertion into the placenta, so that it cannot be stripped off the cord,

although it is readily separable from both the placental and extra-placental chorion (*chorion frondosum* and *chorion lævе*).

At an early period fluid (the liquor amnii) appears within the amnion, separating it from the dorsal surface of the embryo. This gradually increases in quantity as development advances, until at term it amounts on an average to one or two pints ; variations from ten to fifty ounces are, however, not uncommon under normal conditions. At term it is a clear pale fluid of low

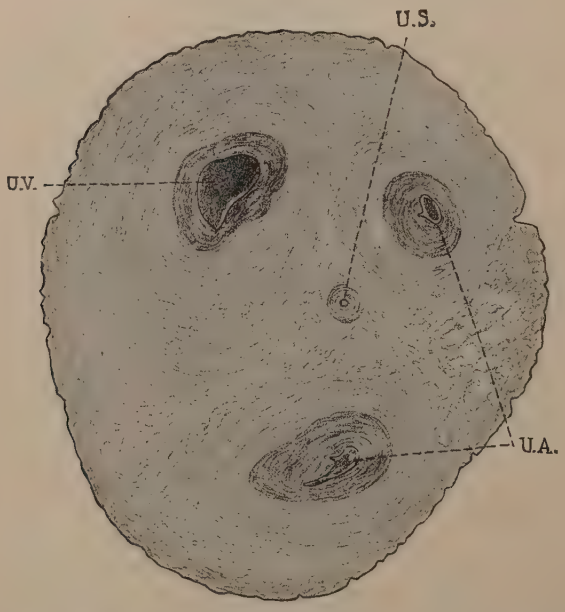


FIG. 38.—Umbilical Cord near Fœtal End, × 5½. (Whitridge Williams.)
U.A.—Umbilical Arteries. U.S.—Remnant of Allantois. U.V.—Umbilical Vein.

specific gravity, and its composition, according to Hoppe-Seyler, is as follows :

Water	98·41 per cent.
Albumen	0·19 ,,
Inorganic salts	0·59 ,,
Extractives	0·81 ,,
	100·00

The amount of albumen present in the early months is much higher than this, and may reach 10 per cent. The most important extractive is *urea*, which is present in traces from the sixth week onwards. Various matters in suspension are also found, such as lanugo hairs, epidermal scales, cells derived from the amniotic epithelium, and particles of vernix caseosa detached from the skin of the fœtus. Glucose may be found in cases of

maternal diabetes. The function of the amniotic fluid is mainly protective. It assists in maintaining an even temperature, acts as a buffer against external injuries, equalises pressure, allows free movements of the fœtus, and flushes the passages from within with a sterile fluid during labour. During labour it also acts as a dilating wedge in the cervix, so long as the amnion remains intact. Nutritive value has been claimed for it on the ground that it is swallowed by the fœtus during the later months of gestation. Certainly lanugo and epidermal scales are not uncommonly found in meconium, and there is no doubt that they have entered the alimentary canal by being swallowed with liquor amnii; sometimes also balls of fine lanugo hairs have been found in the stomach of a dead fœtus. It is possible, therefore, that fluid obtained by swallowing liquor amnii may be of use in the general metabolism of the fœtus.

In spite of much experimental work and clinical observation, the precise origin of the liquor amnii still remains one of the unsolved minor problems of the physiology of pregnancy. It is now believed to have a mixed maternal and fœtal origin: (1) as a transudation from the maternal blood; (2) as a secretion from the epithelium of the amnion, and (3) from the fœtal urine.

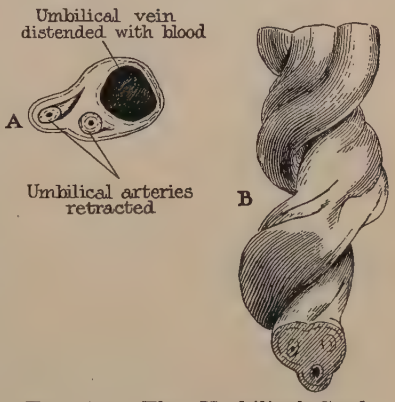


FIG. 39.—The Umbilical Cord at Term.
A. Transverse section showing vesseis.
B. A portion showing torsion.

Umbilical Cord.—This structure connects the body of the fœtus with the placenta. Its earliest appearance in the human ovum is shown in the specimens of Spee (Figs. 20 and 21), where a band of the mesoblastic tissue is seen uniting the embryonic area, with its amnion and umbilical vesicle, to the chorion. This band is the *ventral stalk*. Along it pass the fœtal vessels which vascularise the growing chorion; they are branches of the posterior end of the primitive abdominal aorta. Later the *allantois* also grows into it; this structure is an outgrowth from the hinder end of the primitive gut, and in lower mammals it is larger, and plays a much more important part, than in man. Sometimes in the human ovum the allantois does not extend as far as the chorion at all; and as the ventral stalk may be vascularised before its appearance, it is evident that the part which it plays in the development of the umbilical cord is a secondary one. Later on the *entodermic* or *umbilical vesicle*, with its omphalo-mesenteric (vitelline) duct, also fuses

with the ventral stalk, so that the umbilical cord when fully formed consists developmentally of the following component parts: (1) the ventral stalk; (2) the umbilical blood-vessels from the primitive aorta; (3) the allantois; (4) the umbilical vesicle with its vitelline duct.

In an early embryo (Figs. 36 and 43) the cord is short and very thick; its surface is ridged, and it is attached to the ventral surface close to the caudal extremity. About the third month of gestation four vessels are found in the cord—two arteries and two veins; the veins afterwards fuse to form a single vessel, so that at term there are two arteries and one vein. Traces of the allantois, in the form of a small canal lined by cubical epithelium, may be found in the fœtal end of the cord up to term (Fig. 38). The umbilical vesicle is seen in ova of about the second month to be of considerable size, and attached by a long pedicle to the umbilical cord near its ventral attachment. Later on it disappears, but it is stated that a trace of it may sometimes be found at term in the form of a minute yellowish body at the placental insertion of the cord. The cœlom is also prolonged into the cord, and coils of small intestine may be found at the fœtal end in the early months of gestation, and this condition may persist to term, giving rise to a congenital ventral hernia or *exomphalos*.

FIG. 40.—Umbilical Cord with True Knot. (Charing Cross Hospital Museum.)

At term, the cord varies in length from 5 to 60 inches (12 cm. to 150 cm.), the average being from 18 to 24 inches (45 cm. to 60 cm.). The vessels are always twisted, the arteries usually encircling the vein from left to right; this torsion is evident as early as the third month (Fig. 45), but the cause of it is unknown. The substance of the cord is composed of a special form of embryonic connective tissue, which has been called Wharton's Jelly. It consists of small stellate cells with long processes; anastomosing with others, the processes form a wide network, the meshes of which are filled with gelatinous material (Fig. 41). This connective tissue is irregularly disposed round the vessels, giving rise, in places, to protuberances termed *false knots*, which at times, but not always, contain a loop of vessels. Sometimes a true knot is formed by the fœtus slipping through a loop

of a very long cord *in utero* (Fig. 40). This does not necessarily arrest the circulation through the cord. The epithelial covering of the cord consists at term of stratified cubical cells, resembling the fœtal epidermis (Fig. 42). It is generally believed that these

FIG. 41.—Wharton's Jelly, showing the Stellate Cells. (Galabin and Blacker.)

cells are formed from a prolongation of the fœtal skin over the umbilical cord and are not developed from the amnion.

The cord is usually attached to the centre of the placenta (*central insertion*); it may, however, be placed nearer the margin than the centre (*eccentric insertion*) or upon the edge

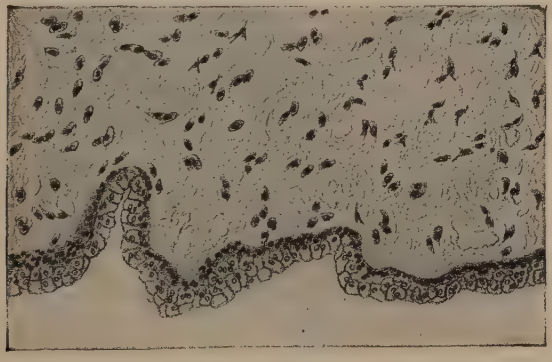


FIG. 42.—Epithelium of Umbilical Cord. (Whitridge Williams.)

(*battledore insertion*), or it may be inserted upon the membranes outside the placenta (*velamentous insertion*) (see Fig. 77). The fœtal insertion of the cord is not subject to variation. It will be noted that while its precursor, the ventral stalk, is attached to the caudal extremity, as the cœlom closes and the umbilical vesicle atrophies, the point of attachment is carried forward until

at the fourth month it reaches the centre of the body of the fœtus.

Fœtus.—During the first six weeks of its development the human embryo is indistinguishable, except by an expert embryologist, from that of other mammals. About the end of the second month it has acquired definite characteristics which serve to distinguish it from others. It is usual to speak of the *embryo* during the first two months, and the *fœtus* later than that period.

In the earliest human ovum which has been carefully described, viz., that of Bryce and Teacher (Fig. 12), the embryo

Fig. 43.—Embryo 9·1 mm. in length, of thirty-one to thirty-four days' development. (His, from Quain's Anatomy.)

is represented by two minute vesicles, amniotic and entodermic, and a thickened layer of ectoderm, the embryonic ectoderm. Not until the end of the fourth week has been reached is the body of the embryo at all clearly defined, and at this stage it measures from 7 to 10 mm. in length (Fig. 43). It is markedly flexed, and the head is nearly as large as the remainder of the body ; the branchial arches are unclosed, the limbs appear as buds, there is a large umbilical vesicle, the umbilical cord is inserted close to the caudal extremity, which is long and pointed, and there is nothing to distinguish it from the embryo of other mammals, such as the rabbit.

During the second month distinctively human features are

developed, and by the eighth or ninth week it measures about 30 mm., and is not so markedly flexed (Fig. 45). The face has become closed in by the growth of the maxillary and mandibular processes, and the eyes and ears have assumed their characteristic form ; the limbs have become divided into their segments, and the digits are well formed. The caudal extremity or tail has become reduced to a minute tubercle.

At the end of the third month the fœtus measures 7·5 to 9 cm. (3—$3\frac{1}{2}$ inches) ; the umbilical cord equals it in length, and its

FIG. 44.—Embryo 15·5 mm. in length, of about five to six weeks' development. (Bryce, from Quain's Anatomy.)

vessels have become twisted ; although the external sexual organs are undifferentiated, the sex may be established by examination of the internal organs.

During the fourth month the muscles become developed and spontaneous movements are made.

The progress of the fœtus in length and weight during the succeeding months of gestation is as shown in the table below. It will be seen that the rate of growth of the fœtus is not only very irregular from one month to another, but subject to considerable variations. A simple method of roughly remembering the length in centimetres of the fœtus (as measured from vertex

to heels) during the first five lunar months is to square the number of the month and, during the last five lunar months, to multiply the number of the month by five. Thus, the length at the end of the fourth month, $4 \times 4 = 16$ cm. (6 inches); at

FIG. 45.—Embryo 30 mm. in length, of about nine weeks' development. (Bryce, from Quain's Anatomy.)

the end of the seventh month, $7 \times 5 = 35$ cm. (14 inches). By inverting the process the period of development of the fœtus

Period.	Length.	Weight.
End of 4th month (lunar)	10 to 17 cm. (4 to 6½ in.)	¼ lb.
5th ,, ,,	18 to 27 ,, (7 to 10½ ,,)	½ ,,
6th ,, ,,	28 to 34 ,, (11 to 13½ ,,)	1½ ,,
7th ,, ,,	35 to 38 ,, (14 to 15 ,,)	2½ ,,
8th ,, ,,	39 to 41 ,, (15½ to 16½ ,,)	3½ ,,
9th ,, ,,	42 to 44 ,, (17 to 17½ ,,)	4¼ ,,
10th ,, ,,	50 to 53 ,, (20 to 21 ,,)	7 to 7½ ,,

may be roughly approximated from its length. Thus a length of 35 cm. would correspond to the end of the seventh lunar month (35 cm. ÷ 5 = 7). The length is a more accurate guide to the age of a fœtus than its weight.

At the end of the seventh lunar month (28th week) the fœtus becomes capable of surviving when born—*i.e.*, it becomes *viable :* its chances of survival at this period are, however, very small. A twenty-eight weeks' fœtus has the skin of a deep, dull red colour, there is hair on the scalp, and a little sebaceous secretion has been produced. In the male the testicles have descended into the scrotum.

At the thirty-sixth week the fœtus has increased greatly in bulk, but not so markedly in length. The colour of the skin is a brighter pink, and light delicate hair (lanugo) covers the whole of the body except the scalp, where long dark hair is seen. The general surface of the body is covered with a deposit of sebaceous matter (*vernix caseosa*), and a well-defined layer of subcutaneous fat has appeared, giving rotundity to the outlines of the trunk and limbs. The abdomen is still relatively protuberant, especially in the upper part.

During the last four weeks the chief change is a great gain in length and weight and increase in potential activity. The free and energetic movements which the fœtus makes habitually during this period no doubt contribute to its muscular development.

The Mature Fœtus.—Though subject to considerable variations, the average length of the fœtus at term is about 50 cm. (20 inches) and the average weight 7 to 7½ pounds. Males are usually rather heavier than females. Weight is much more variable than length, for from various causes a mature fœtus may weigh much less than the average, while, from disease, a premature fœtus may equal it in weight. Healthy mature infants may weigh only 5 to 5½ pounds, but any weight below this is probably to be attributed to pre-maturity, to hereditary syphilis, or other maternal disorder. A fœtus weighing over 10 pounds is not rare ; a weight of over 12 pounds is, however, very uncommon and is usually accounted for by post-maturity—*i.e.* undue prolongation of the period of gestation. The general differences between a premature and a mature fœtus may be tabulated as shown on p. 52.

The Fœtal Circulation.—The umbilical vein, which brings purified arterial blood from the placenta, enters the trunk at the umbilicus and runs beneath the anterior abdominal wall to reach the lower surface of the liver (Fig. 46, *vu.*). Here it gives off branches to the left lobe, the lobus quadratus and lobus Spigelii, which thus receive a direct supply of pure blood from the placenta. It then gives off another branch which joins the portal vein (*vp.*) as the latter is about to enter the right lobe ;

as the portal vein brings impure blood from the alimentary canal, the blood-supply of the right lobe of the liver is less pure

Seven months' Fœtus.	*Mature Fœtus.*
1. Skin lax, wrinkled, dull red in colour, little vernix caseosa.	Skin smooth, plump, pink, covered with vernix caseosa.
2. Subcutaneous fat scanty.	Subcutaneous fat abundant.
3. Hair on scalp short.	Abundant dark hair on scalp, 1 to 1¼ inch long.
4. Lanugo present over whole body.	Lanugo absent from most situations.
5. Short nails on fingers and toes.	Nails project beyond finger tips.
6. Skull sutures open.	Skull sutures closed (*i.e.* bones in contact) except at fontanelles.
7. Moves and cries feebly when born.	Moves and cries vigorously when born.

than that of the other lobes. After giving off these branches to the liver, the umbilical vein, now reduced in size, and called the *ductus venosus* (*dv.*), enters the inferior vena cava (*vci.*). Blood which has passed through the liver is carried by the hepatic veins (*vh.*) to the same great venous trunk, which now contains a mixed stream consisting of pure blood from the ductus venosus, and impure blood coming up from the lower extremities through the iliac veins, and from the liver through the hepatic veins. The blood brought up to the heart by the inferior vena cava is, however, still, comparatively speaking, pure, for the amount of impure blood carried into this vessel by the hepatic and iliac veins (lower extremities and pelvis) is relatively small.

The inferior vena cava enters the floor of the right auricle, and the blood-stream is immediately directed by the *Eustachian valve* through the *foramen ovale* into the left auricle ; thence it flows through the mitral valve into the left ventricle, and thence into the aorta. From the aorta branches pass to the head, neck, and upper extremities through the innominate, left carotid, and left subclavian trunks ; excepting the liver, these parts therefore receive the purest supply of blood. From these parts the venous blood is returned to the right auricle by the superior vena cava (*vcs.*) ; thence it passes through the tricuspid valve to the right ventricle. There are therefore two blood-currents crossing each other in the right auricle, and it is believed that they are completely separated from each other by the Eustachian valve. From the right ventricle the blood passes into the pulmonary artery, which, after giving off branches to the lungs, passes on, as the *ductus arteriosus* (*da.*), to join the thoracic aorta near the origin of the left subclavian artery. The abdominal aorta (*ao.*) now contains a very mixed supply of blood consisting of a small amount of arterial blood from the placenta, which has passed from the right auricle through the Eustachian valve to the left side of the heart, and a large amount of venous blood from the

lower extremities and pelvis (iliac veins), liver (hepatic veins), and head, neck, and upper extremities (ductus arteriosus). The

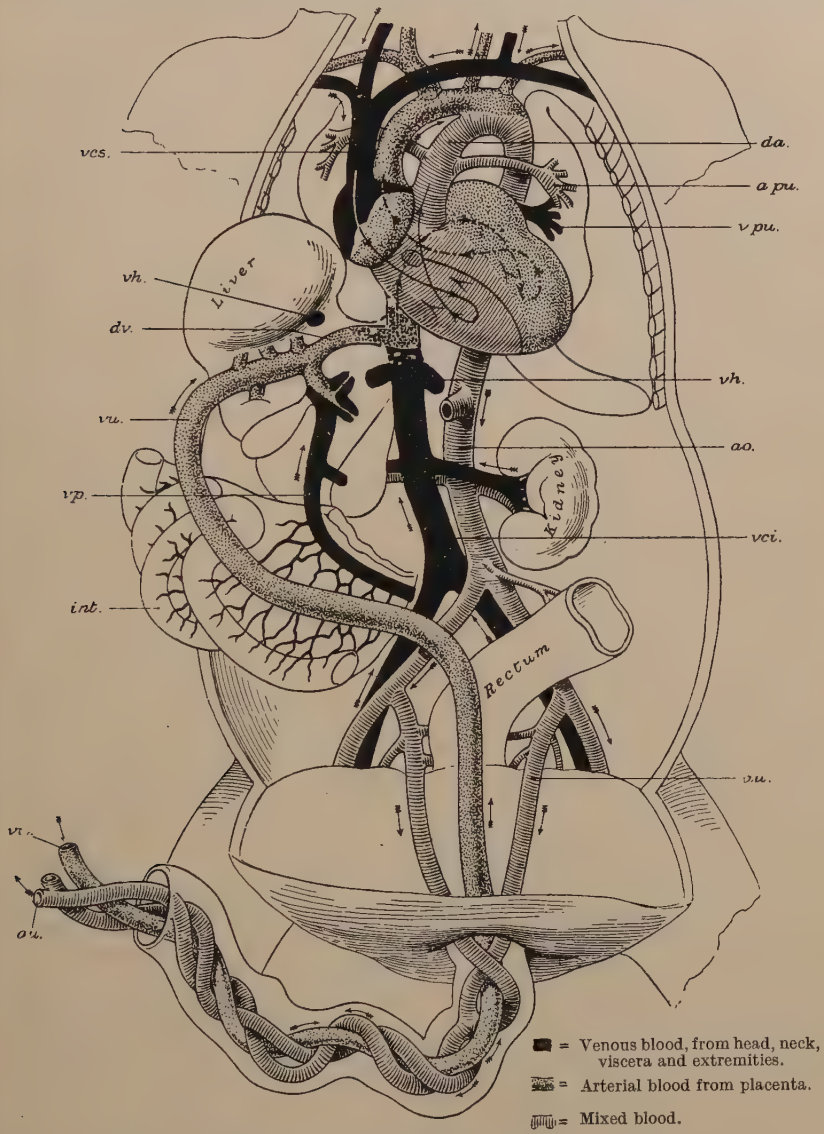


FIG. 46.—Scheme of the Fœtal Circulation. (Edgar.)

aorta divides into the two iliac arteries ; each of these in turn divides into (1) a hypogastric or umbilical artery (*au.*), giving off twigs to the pelvis, and then passing into the cord, and so to

the placenta, and (2) an external iliac branch running to the lower limbs. The curious anomaly is thus presented that the arterial supply of the lower extremities is derived from the same trunk as the venous blood which is carried to the placenta to be purified. The blood carried to the placenta by the umbilical arteries passes through the villi, and is returned in a purified state to the fœtus through the umbilical vein (*vu.*).

Changes in the Fœtal Circulation at Birth.—These are due to two causes: (1) the expansion of the lungs by respiration; (2) the arrest of the placental circulation. The immediate effect of respiration is to divert a great part of the blood from the right ventricle to the lungs, and the ductus arteriosus accordingly becomes greatly contracted. The immediate effect of arresting the placental circulation is to reduce the pressure in the right auricle by diminishing the quantity of blood entering it through the inferior vena cava. At the same time the pressure in the left auricle is raised by the increased amount of blood returned to it from the lungs; the pressure in the two auricles is thus more or less equalised, the flap valve of the foramen ovale closes, and the passage of blood from the right to the left auricle is arrested. The umbilical vessels, ductus arteriosus, and ductus venosus become gradually occluded by thrombosis, but all may persist in the form of fibrous cords in the adult. The transition from the fœtal to the adult type of circulation is probably completed in a few days.

General Physiology of the Fœtus.—This is naturally an extremely difficult subject, and only its more important aspects will be considered here. The first point to be emphasised is that the nutritive material provided for the fœtus comes from the food supply of the mother, and is not taken from the maternal tissues. If, however, the mother is insufficiently nourished, there is no doubt that the fœtus draws on her tissues for its food supply, and it is interesting to note that in cases of maternal starvation the fœtus is usually born plump. The mode of the placental transmission of nutritive material from mother to fœtus has already been described (p. 37), and it now remains to consider a few points about the quantity of the fœtal food requirements. A rough idea of this may be gained by studying the chemical composition of the fœtus at different ages. This has been estimated by Michel, as follows :—

	Water.	Protein.	Salts.	Fats.
	Per cent.	Per cent.		
At 2½ months . .	94	4·5	Trace.	Trace.
			Per cent.	Per cent.
3rd to 4th month .	90	7	1·8	0·04
7th month . .	85	10	2·5	2
At term . . .	69	14	3·4	12

The chief points to be noted in this table are (1) the younger the fœtus, the greater the percentage of water it contains; (2) the mineral constituents and protein content progressively rise as term is approached; (3) the very remarkable increase in the fat content, from 2 per cent. at the seventh month to 12 per cent. at term. The amounts of protein and fat necessary for the daily food requirements of the fœtus are, according to Michel, 6 grammes of protein and 8 grammes of fat. Such amounts are in reality inconsiderable, and show the fallacy of the popular notion that a pregnant woman must over-eat to nourish her unborn baby. A large amount of iron is stored in the body of the fœtus, especially in the liver, and it has been calculated that the amount fixed during the last three months is 0·3 gramme; there seems no doubt that this large amount forms a reserve which is drawn on by the infant after birth to make up for the deficiency of iron in the milk. The fœtal red blood-corpuscles have a very high hæmoglobin content, and the colour index of the blood is higher than in the adult. The calcium requirements of the fœtus are high, especially during the last three months of pregnancy. The fœtus contains a large amount of glycogen, which is almost universally distributed throughout its tissues. The energy of the fœtus is supplied by the combustion of carbohydrates, and the wide distribution of glycogen provides an available supply in every part of the body in which the work of organisation is proceeding.

Attention has been already drawn to the large size of the fœtal liver in the early months, and to the remarkable arrangements for supplying it with purified blood. At the fourth week of gestation the fœtal liver has attained a predominant size among the abdominal viscera; during the second month this predominance increases, causing protuberance of the upper abdomen. In the later months it becomes proportionately smaller, but even at term it is unduly large, for it weighs one-eighteenth part of the total body-weight of the fœtus, while the proportion in the adult is one-thirtieth. In the third month the gall-bladder contains a yellow fluid, in which bile salts and acids can be detected, and which is therefore a true biliary secretion. Bile pigment appears later; but glycogen and urea, both products of hepatic activity, are also present in the fœtal tissues at an early period of development. There can be very little doubt that in fœtal physiology the liver plays an important part, which may perhaps be as much constructive as excretory.

The chief excretory organs—the kidneys and the skin—are also functionally active in the fœtus. We do not know the precise period at which the kidneys begin to secrete urine, but during the last two months of development the bladder usually contains a little clear fluid, in which urea, albumen, and chlorides

can be detected, and which is therefore a true renal secretion. Sebaceous glands appear in the skin at the fifth month, the sweat-glands somewhat later. The structure of the fœtal epidermis is very simple, the horny layer being practically absent, and transudation from the fœtal capillaries into the liquor amnii probably takes place with ease. The traces of urea found in the amniotic fluid may therefore reach it directly from the blood by passing through the skin. The vernix caseosa is the abundant product of the active sebaceous glands.

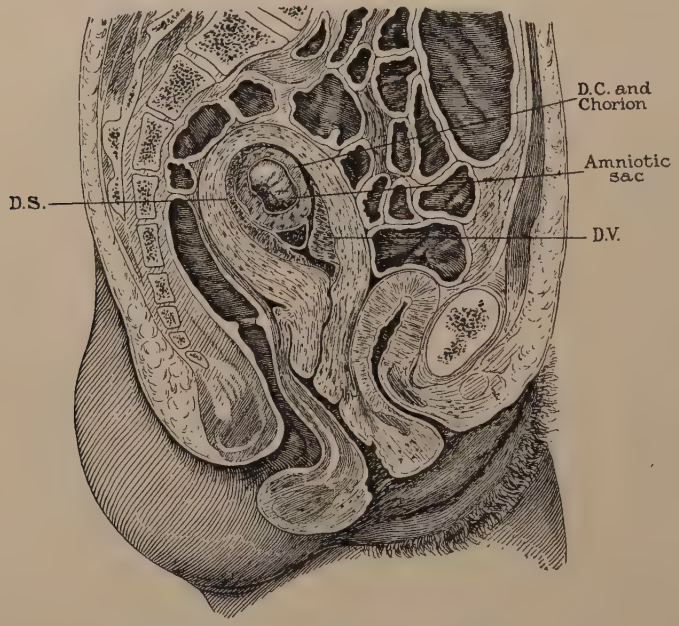


FIG. 47.—Gravid Uterus at End of Second Month (Eighth Week). From a Frozen Section. (Braune.)

The uterus is retroverted, but shows the expansion of the body-cavity. D.C. Decidua capsularis. D.S. Decidua basalis (serotina). D.V. Decidua vera.

The meconium found distributed in the gut of the mature fœtus, from the duodenum to the rectum, is chiefly composed of the waste products of the hepatic secretion. It also often contains numbers of lanugo hairs and squamous epithelial cells, which can be recognised under the microscope; the only possible way in which they can reach the intestine is by the fœtus swallowing quantities of its liquor amnii, in which these elements are always to be found in suspension. The uniform distribution of this substance throughout the gut indicates that peristalsis is present in the fœtal intestines, otherwise accumulation in the upper part would necessarily take place.

The Gravid Uterus.

The uterus undergoes a remarkable series of changes during pregnancy, which are without parallel in any other organ.

FIG. 48.—Gravid Uterus at the Thirteenth Week.
(Galabin and Blacker.)

They result in an increase of weight from $1\frac{1}{2}$ to 2 ounces before impregnation to 2 to $2\frac{1}{2}$ lbs. at term.

Changes in Shape and Size.—During the first month of

gestation the uterus undergoes no clinically appreciable alteration in shape or size, but towards the end of the second month well-marked alterations are apparent. The body of the normal non-gravid uterus has the shape of a pear flattened in an antero-posterior plane ; during the second month it expands in the antero-posterior plane, but is still wider at the fundus than below. At the eighth week the uterine body measures about 2 inches in vertical by $1\frac{1}{2}$ inches (5 cm. by 4 cm.) in transverse diameter (Fig. 47). The normal anterior inclination of the uterus is now somewhat exaggerated, and the angle between body and cervix may be slightly diminished (anteflexion). At the end of the third month (twelve weeks) it is nearly globular in shape, and has greatly increased in size, measuring about $3\frac{1}{2}$ to 4 inches (9 cm. to 10 cm.) in diameter (Fig. 48). It has now become large enough to fill the pelvic cavity, and in a primigravida (a woman pregnant for the first time) may be felt just above the level of the pubes on abdominal palpation. In a multipara it is often higher than this. At the end of the fourth month (sixteen weeks) it has again become distinctly pyriform in shape (Fig. 49) ; the vertical diameter is about 6 inches (15 cm.), and the fundus may be felt nearly midway between the umbilicus and the pubes. The pyriform shape is henceforth preserved until term. Measurements of the height of the fundus above the pubes (Fig. 54) are somewhat fallacious, but at the end of the fifth month (twenty weeks) the uterus usually extends up to a level lying two-thirds of the distance between the symphysis and the umbilicus, and at the end of the sixth month (twenty-fourth week) the fundus has reached the umbilicus ; at the end of the seventh month (twenty-eight weeks) it is nearly midway between the umbilicus and the tip of the xiphoid cartilage ; the highest point is reached about four weeks before term, when the fundus extends to the tip of the xiphoid cartilage, and often passes upwards underneath the costal margin slightly everting the lower ribs. It then sinks a little lower in the abdomen ; this descent is, however, not observed in every case, and may be delayed until labour has actually begun. The average height of the fundus above the pubes at term is about 10 to 12 inches (25 cm. to 30 cm.), being a little greater in a multipara than in a primigravida ; the widest transverse diameter of the uterus is $8\frac{1}{2}$ to 9 inches (21 cm. to 22 cm.). As seen in frozen sections, the uterus from the fifth month onwards is markedly moulded posteriorly upon the vertebral column (Figs. 49 and 50).

The ovum does not completely fill the uterine cavity until the end of the thirteenth week (Figs. 17 and 48) ; until then a space persists, known as the *decidual space*, lying below, or below and to one side of, the ovum. During the fourth month the decidua vera and capsularis become closely apposed, obliterating this space, and bringing the ovum directly over the

os internum (Fig. 49); the same relation is thence maintained to term.

Changes in Relations.—The position of the gravid uterus after it has risen out of the pelvis is rarely precisely mesial; it is usually deflected to one or other side, more often to the right than the left. This is called the *lateral obliquity* of the

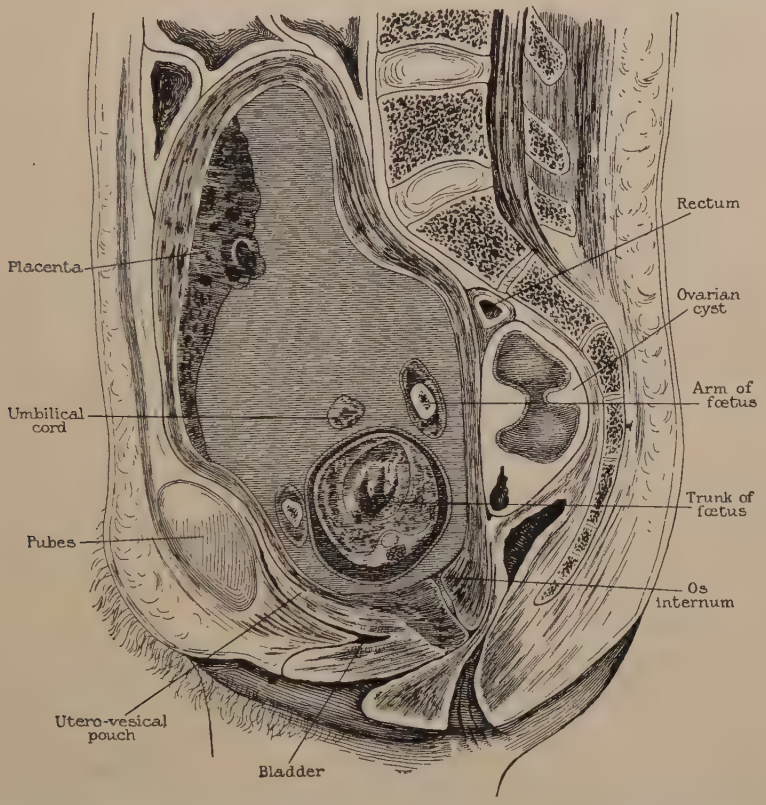


FIG. 49.—Gravid Uterus at Eighteenth Week. From a Frozen Section. (Clarence Webster.)

uterus. It is also believed that rotation on a vertical axis occurs, bringing one or other—usually the left—cornu forwards towards the abdominal wall. This rotation can sometimes be observed when the uterus is exposed in the operation of Cæsarean section. The normal position of anteversion (tilting forwards) of the body of the uterus is often exaggerated during the first two months; afterwards the uterine axis becomes almost erect; later still the organ becomes moulded upon the vertebral column, and towards the end of pregnancy the

tendency to anteversion again appears, especially in multiparæ with lax abdominal walls; these changes in the degree of anteversion produce corresponding variations in the position of the cervix which are appreciable to clinical examination. Thus during the first two months the cervix is carried backwards by exaggerated anteversion of the fundus, until the external os is difficult to reach with the finger. Later on it becomes more central, and the os is easily reached. As term approaches the cervix again becomes displaced backwards by descent of the head, and it may be quite difficult to reach it when labour sets in.

The relations of the uterus to its peritoneal investment undergo considerable changes. The uterine peritoneum develops proportionately with the growth of the uterus, and the anterior and posterior peritoneal pouches are preserved (Fig. 50). The utero-sacral folds rise up to the level of the pelvic brim, and since the level of its floor remains unaltered, the pouch of Douglas at term is very deep indeed. The lateral reflections also rise considerably, so that at term the bases of the broad ligaments may be described as being at the level of the pelvic brim (Barbour); this leaves a large area of the lowest part of the uterine wall on each side uncovered by peritoneum. Considerable increase of connective tissue between the folds of the broad ligament, in relation to each lateral uterine wall, occurs during pregnancy. The round ligaments undergo considerable hypertrophy, so that they may in some circumstances be palpated through the abdominal walls. The bladder remains a pelvic organ up to term, and the level of the utero-vesical pouch is unaltered throughout pregnancy (Fig. 50).

Changes in the Uterine Muscle.—The presence of a developing ovum in the uterus sets up a progressive series of changes in that organ of a hypertrophic character, the immediate effect of which is to enable the uterus to contain the fœtus during the whole period of its growth. These changes are brought about partly by hypertrophy of muscle, partly by the distending force of the growing ovum. They must be regarded as a part of the general physiological reaction of the maternal organism in pregnancy, to which further reference will shortly be made.

The average thickness of the uterine wall at term is about half that of the non-pregnant organ, which is from $\frac{3}{4}$ to 1 inch (2 cm. to 2·5 cm.), but there are variations in different parts. The posterior wall is fairly equal throughout; the anterior becomes thinner in its lower part before it joins the cervix. Both hypertrophy of existing muscle fibres, and new formation of muscle occur in the gravid uterus. Increase of the elastic tissue is also said to occur, but the connective-tissue elements of the uterus are, generally speaking, much less affected than the muscular elements. According to Kölliker, the muscle

fibres in the second half of pregnancy are ten times as long and twice as broad as in the non-gravid state. New formation of muscle fibres only occurs during the first six months, and affects chiefly the deeper layers of the musculature. During the course of pregnancy a more or less definite arrangement of the musculature of the body of the uterus into three layers occurs, but this change does not affect the cervix. The *outer* layer consists partly of longitudinal, partly of transverse fibres ; the former

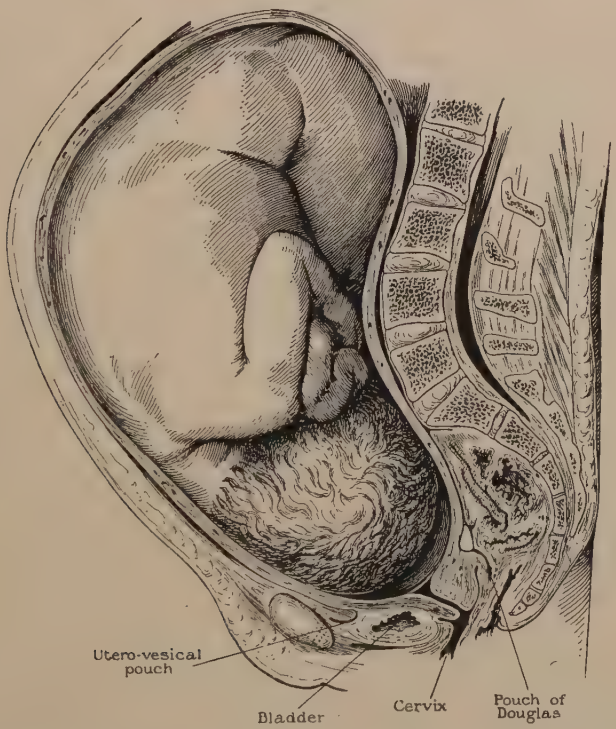


FIG. 50.—Frozen Section of Gravid Uterus at Term. (Leopold.)

are found in the form of a broad mesial band, running from the level of the internal os in front over the fundus to the same level behind ; the latter cross the uterus in front and behind and pass out into the broad ligaments. The *middle* layer greatly exceeds either of the other two in thickness and is closely united with them ; it forms a close reticulum of interlacing fibres, through which run the large arterial and venous channels ; around the vessels it forms powerful rings of arcuate fibres, arranged somewhat in the form of figures of 8. The *internal* layer is very thin, and is composed mostly of annular figures,

which encircle the whole uterus, and are specially developed at the cornua around the openings of the Fallopian tubes.

The Lower Uterine Segment.—It has been mentioned that the lower part of the anterior uterine wall becomes thinned for a short distance above the level of the internal os. Over this part the peritoneal coat is loosely attached, and can be readily stripped off. It will be remembered that in the non-gravid uterus the peritoneum is loosely attached in the same position. Upon the posterior wall there is neither thinning of wall nor loose attachment of peritoneum. The part of the uterine body roughly corresponding to the area of loose peritoneal attachment is called the *lower uterine segment.* It was at one time believed that the lower segment could be *precisely* defined in this manner, but it now appears that the area of loose peritoneal attachment is subject to much greater variation than was formerly supposed (Barbour). Although defined in this way only upon the anterior wall, the lower uterine segment forms a complete zone. It is said that microscopically the arrangement of the bundles of muscle fibres is somewhat different in the lower segment from the remainder of the uterus (Barbour). Its special functions are connected with the process of labour, and the subject will be again referred to in that connection (see p. 240.) The normal situation of the placenta is any part of the uterine wall above the lower segment; when the placental site encroaches upon this part of the uterus the condition of *placenta prævia* is produced. The development of the lower segment in pregnancy can be traced roughly by measuring the distance between the internal os and the level of firm peritoneal attachment; in this way it has been shown to increase from 2·3 cm. at the fourth month to 6 cm. at term. From what has been said of the relations of the peritoneum it will be perceived that at term the lateral aspects of the lower segment have no peritoneal investment, for they lie between the layers of the broad ligaments, the bases of which are greatly elevated.

The Cervix undergoes few alterations of importance during pregnancy. It preserves the naked eye characters of its mucous membrane, which does not become transformed into a decidua. It has been shown, however, that decidual cells may be found in the upper part of the cervical mucous membrane, and it is therefore probable that the changes characteristic of pregnancy do not end abruptly at the internal os, but may be traced in diminishing degree into the cervix (Aschoff). The cervical canal is filled with a thick plug of mucus. Its muscular coat does not hypertrophy, and it preserves the usual arrangement of its fibres in a dense network. Its relations to vaginal vault, cellular tissue, and peritoneum remain unaltered. It was formerly believed, from clinical observations, that the cervix

became shortened during pregnancy ; the study of frozen sections of the gravid uterus *in situ* has shown that the length of the canal is fairly constant and does not differ from that of the non-gravid organ (Fig. 103). Clinically, however, a marked change occurs which is known as ' softening of the cervix.' It is found first at the lips of the os externum and gradually advances from below upwards until at term the whole of the portio vaginalis is softened. The histology of this change is obscure, and up to the present time no satisfactory study of it has been made ; increased vascularity probably explains it in part. The surface of the portio vaginalis undergoes a variable degree of blue discoloration early in pregnancy. As term approaches the internal os often becomes a little dilated in a multipara, and the same change is occasionally found in a primigravida.

Uterine Contractions.—Throughout pregnancy the uterine muscle manifests a certain amount of activity. Intermittent contractions take place, feeble in the early months, but becoming more pronounced as the uterus develops, which bear a general resemblance to the uterine contractions, or ' pains,' of labour. They are intermittent and involuntary, but they differ from the contractions of labour in being painless—the patient is quite unconscious of them. Being palpable by abdominal examination, they form a clinical sign of great diagnostic importance in the later months of pregnancy. They are probably excited by some reflex mechanism, in which the ovum provides the peripheral stimulus ; while the active hypertrophy of the uterine muscle makes the response to this stimulus very pronounced. Even when spontaneous contractions are imperceptible, hardening and contraction of the uterus can usually be induced by a gentle stimulus, such as rubbing with the hand.

The General Physiology of Pregnancy.

The presence of a developing ovum in the uterus occasions a progressive series of anatomical and physiological changes not only in the generative system but in the whole maternal organism. Widespread alterations occur in the structure and functions of many of the important organs, and the general metabolism of the body is definitely modified throughout the whole period of pregnancy. The changes are essentially associated with the supply of nutriment and energy necessary for the growth of the developing ovum, and with the preparation for the maintenance of the infant after birth. There can be no doubt that a potent physiological force resides in the developing ovum. What precisely is the original stimulus for the changes that occur in pregnancy is not known ; the central and sympathetic nervous systems have no influence, and it seems certain that the phenomena of pregnancy, as well as of parturition, are brought about

by chemical stimuli acting through the blood-stream. It is possible that the hormone may arise in the corpus luteum.

The General Physiological Changes in Pregnancy.—Under this heading must be grouped not only the well-known and obvious changes such as those which occur in the breasts, but also the more recently investigated alterations which occur in the general metabolism of the body. Physiological forces must be studied mainly through the effects they produce ; at this early stage of our knowledge therefore, it will be necessary to speak chiefly of structural and chemical changes, and little of the manner in which they are brought about.

FIG. 51.—The Mamma in a late stage of Pregnancy, showing the Secondary Areola. (Galabin and Blacker.)

Mammary Glands.—These organs cannot be said to be fully developed until pregnancy has occurred, and has been followed by a period of lactation. In a primigravida (a woman in her first pregnancy) they undergo a series of changes, many of which persist after the glands have returned to their resting phase ; the breasts of a parous woman who has suckled her children therefore differ greatly from those of a nullipara. The size of the mamma is very variable in healthy women, as are also the size and appearance of the nipple and areola. In a first pregnancy the whole gland increases in size, and undergoes a true hypertrophy, which affects not only the glandular acini, but also the connective-tissue stroma. This hypertrophy is first recognisable clinically in the peripheral lobules of the gland, which become tense, nodular, and slightly tender to the touch. It usually appears at about the end of the second month, although it may be delayed until the fourth month. When the hypertrophy of the lobules is well marked, a little clear pale-yellow secretion can usually be expressed by gently compressing the base of the gland and squeezing it towards the nipple. The nipple and areola become more deeply pigmented, but this change varies much in intensity in women of different complexion, being more marked in brunettes than in blondes. Upon the areola a series of ten to twenty small non-pigmented nodules

appear, consisting of enlarged sebaceous glands and known as 'Montgomery's tubercles' (Fig. 52); they are not, however, invariably present. Usually the areola becomes more prominent than normal, and around it is formed an outer zone of irregular and less marked pigmentation, known as the *secondary areola* (Fig. 51). As shown in Fig. 52, the secondary areola usually consists of a well-defined reticulum, forming a tesselated arrangement of pale quadrilateral areas enclosed in the meshes of a pigmented web. An increased vascular supply, indicated by dilated veins under the skin, accompanies the hypertrophy. Often towards the close of a first pregnancy the skin itself becomes stretched, and small patches of the cutis vera becoming

FIG. 52.—The Nipple and Areola of a Primigravida, showing the Tubercles of Montgomery, the Secondary Areola, and several dilated veins.

thinned, give rise to the appearances known as *striæ* (see p. 67). The secretion varies in character during pregnancy; when first seen it is usually a thin straw-coloured fluid resembling serum; later it becomes thicker, more opaque, and more distinctly yellow in colour.

In the breasts of a multipara the changes characteristic of early pregnancy can seldom be detected, for the reasons stated above. After a period of full functional activity (suckling) a little *milk* may be present in the breasts for several years, and may be found on squeezing them. But if the breasts of a multipara contain thin serous fluid instead of milk, a fresh phase of activity, *i.e.*, an early pregnancy, is indicated.

These changes indicate an 'activation' of the mammary glands during pregnancy, which is recognisable from the second month onwards. In degree and in the rate of advance considerable variation may be noted, but the glands never remain absolutely quiescent during pregnancy. The acme of the process of activation does not occur, however, until three or four days after the birth of the child. The breasts then become engorged with secretion to an extent which makes them swollen and painful, but which is relieved by the natural process of suckling. Once fully established, mammary activity will be maintained for several months, under the stimulus of suckling, without the renewal of the original physiological stimulus. Occasionally puerperal activation is deficient, and the mother has not enough milk to feed her child.

The means by which pregnancy induces mammary activity are not known, but there can be no doubt that there is a direct relation of cause and effect between them. No other condition than pregnancy can excite the mammary function to anything like the same extent; the stimulus is continuous and progressive in intensity throughout pregnancy; untimely interruption of pregnancy leads to immediate mammary retrogression. The physiological mechanism at work is probably complex. Biochemical changes are no doubt the main factor, and a 'hormone' is probably produced in the gravid uterus, which directly or indirectly acts upon the mammary gland. Whether the hormone is of maternal or fœtal origin is not determined, and the point is not of great importance. Starling and Lane-Claypon experimentally produced mammary hypertrophy in virgin rabbits by injection of extracts made from the fœtus of the rabbit, and from this result they conclude that the mammary stimulus is of fœtal origin. These conclusions, however, must await confirmation. The fact that mammary activity persists for so long after the production of the pregnancy 'hormone' has ceased, indicates that the action is indirect. It has been suggested by Schäfer that this indirect action may be exerted through the pituitary body. It is known that in animals this gland undergoes well-marked hypertrophy in pregnancy; it is now known that the same change occurs in women, and the persistence of this hypertrophy may explain the hypersecretion of the early puerperium and the continuance of activity, aided only by the mechanical stimulus of suckling, during the period of lactation. The administration of the dried extract of the pituitary to nursing women is sometimes useful as a galactagogue.

Cutaneous System.—The changes occurring in the cutaneous system may be arranged in two groups: some are *mechanical* and are due to stretching of the skin, such as the striæ; others are truly *biological*, such as pigmentary changes, mal-

nutrition of the cutaneous appendages, and the appearance of eruptions.

Striæ gravidarum appear on the abdominal wall similar to those found on the breasts. When recently formed they are pearly or pinkish in colour, and linear in outline ; they vary in length and breadth, and are most marked below the umbilicus ; sometimes they are also seen on the adjacent parts of the buttocks and thighs. After labour is over they become pale and silvery, *i.e.*, cicatricial, and are known as *striæ albicantes*. In a multipara some may be found in the recent state ; others are old, and represent the changes which have occurred in a previous pregnancy. The capacity of the skin to resist the effects of stretching varies in individuals, for sometimes these marks are not produced at all in pregnancy. On the other hand, similar striæ may be produced by abdominal distension due to causes other than pregnancy.

Pigmentary changes.—The changes in the breasts have been already referred to. On the abdomen a mesial line of pigmentation, running from above the umbilicus to the pubes, appears during the second half of pregnancy ; it is called the *linea nigra*. In a dark-complexioned woman it may be broad and dark, and in a fair woman it may be barely visible. In dark-complexioned, non-pregnant women a similar line may sometimes be seen, so that its presence is not a sure indication of pregnancy. On the face irregular patches of dark brown pigmentation sometimes occur, being most marked on the forehead, the sides of the nose, and the upper lip, but the whole face may be affected. It is called the pregnancy mark or *chloasma*. Sometimes extensive pigmentation occurs on the trunk in irregular patches, alternating with patches from which the natural pigment has largely disappeared. In some cases the distribution is not unlike that seen in Addison's disease. As a rule the pigmentary changes disappear after labour, but sometimes, on the trunk, they remain permanent.

Signs of malnutrition may be found, such as an increased tendency to falling of the hair ; in the same category, as teeth are of epidermal origin, may be placed the rapid advance of dental caries.

Eruptions of erythematous, papular, or pustular type are frequent accompaniments of morbid complications of pregnancy.

Circulatory System.—The *blood* undergoes modifications which are fairly constant, and upon which observers are agreed. In animals the total volume of the blood is increased during pregnancy, and the same change can fairly be assumed to occur in women. The quality of the blood, however, deteriorates, for the proportion of water increases, while the proportions of red cells and hæmoglobin diminish ; these evidences of anæmia are most marked about the middle of pregnancy, but even at

term the average number of red cells is under 4,000,000 per c.mm. A definite excess of white corpuscles is found in the blood during pregnancy, the excess being much higher in a primigravida than a multipara. It is most marked towards the close of pregnancy, when the numbers vary from 8,000 to 15,000. During labour a further increase up to 20,000 occurs, and after labour the number may reach 25,000, but thereafter rapidly falls. The specific gravity is progressively diminished up to the middle of pregnancy, and rises again to normal at term. The amount of calcium salts present is slightly increased, while that of fibrin diminishes up to the sixth month, when it begins to rise again to normal at term. It will thus be seen that a certain deterioration in the quality of the blood is evident during the first half of pregnancy. There is also a distinct diminution in the CO_2 combining power of the blood: the so-called 'alkali reserve' of the blood (Marshall).

The *heart* was for a long time believed to undergo hypertrophy during pregnancy. There has been much conflict of observation upon the point, but it is now generally held that the weight of the heart is not appreciably increased, and therefore there can be no hypertrophy. A certain amount of dilatation probably occurs, affecting chiefly the right side of the organ. In the *venous system* evidences of increased back-pressure are frequently found in the form of hæmorrhoids, slight anasarca of the feet, and varices of the lower extremities and vulva.

Blood Pressure is believed to be slightly raised during the later months of pregnancy, but great differences of opinion exist as to what is the normal for young adult non-pregnant women. From clinical observations Bailey estimates that a pressure of 118 mm. of Hg is normal for the last month, and this is hardly above the average. In certain morbid conditions, notably eclampsia, a high blood pressure, which may reach 150 mm. to 200 mm., is commonly found.

The Endocrinous Bodies.—Recent investigations have shown that these organs undergo remarkable changes in the direction of 'activation' in animals, and it may be assumed with confidence that they occur in women also. It has been known to clinical observers for generations that goitre undergoes rapid enlargement during pregnancy, and careful observation has shown that the normal gland also often enlarges. The other endocrinous bodies are inaccessible to clinical examination, and confirmation of their participation in pregnancy can only be gathered as opportunity offers. It may be said, however, that in animals the pituitary, the pineal, the adrenals, the thymus, and the parathyroid bodies all show enlargement accompanied by minute changes in their cells, indicative of hyperactivity. The conclusion is that the amount of

their internal secretion is raised above the normal, and the physiological effects they produce are exaggerated. The functions of these glands are by no means fully known, but certain of the general effects of pregnancy already described may very well be due to them. Thus the activation of the mammary glands and the rise in blood pressure may be brought about indirectly through the pituitary, the pigmentation of the skin through the adrenals, the leucocytosis through the spleen, and the increased output of calcium through the ovaries.

Other Organs.—The *nervous system* becomes functionally disturbed in women of neurotic tendencies, and such conditions are manifested as irritability, sleeplessness or constant drowsiness, neuralgia, perversion of appetite by the so-called 'longings,' &c. But in women whose nervous system is in a state of stable equilibrium these disturbances of function do not occur. Towards the end of pregnancy the size of the uterus causes some embarrassment of respiration, which becomes almost entirely costal in type; and cramps in the muscles of the legs are frequent from pressure upon the lumbar and sacral plexuses. The *bladder* usually shows some irritability about the second month, but this passes off and does not recur until the close of pregnancy, when not uncommonly micturition again becomes frequent and painful. *Nausea and vomiting* are usually present in the early months (see Morning Sickness, p. 74), and there is a common tendency to constipation and the formation or aggravation of hæmorrhoids. A slight decrease in the total acidity of the gastric secretion and in the amount of free hydrochloric acid accompanies pregnancy. The *pelvic articulations* undergo slight softening of ligaments and general loss of firmness and strength.

The liver also enlarges and becomes congested, and certain recent observers have maintained that a zone of slight fatty degeneration may be found in the centre of the hepatic lobule around the central vein, which is dilated. But there is no convincing evidence that there is a hepatic insufficiency during normal pregnancy.

There is also evidence that many other organs, not directly connected with the generative system, show definite changes in pregnancy. Thus, patches of congestion and swelling of the mucous membrane of the larynx commonly occur, resulting in alteration of the tone and quality of the voice in singers. Similar patches of congestion and swelling occur in the mucous membranes of the bladder and ureter.

Changes in the General Metabolism during Pregnancy.—During the past few years elaborate investigations into the metabolism-balance of pregnant women have been made, and definite modifications and alterations in the maternal metabolism are now recognised as physiological to pregnancy. It has been shown that the assimilation and excretion of the

chief tissue constituents are regulated so as to provide what is required for the development and growth of the fœtus. So accurately is metabolism adjusted that the maternal organism suffers no loss during pregnancy, but can be shown actually to lay up larger stores of certain elements. Pregnancy may therefore be regarded, in the words of Paul Bar, as a state of 'harmonious symbiosis' between mother and fœtus. The nutritive material which the mother has to provide for the fœtus comes from her own food supply, and not from a depletion of her tissues: it has already been pointed out (p. 55) that the requirements of the fœtus are, in terms of food, inconsiderable. It is only when her diet is inadequate that the mother draws on her own tissues; under such circumstances the mother suffers long before the fœtus. Pregnancy is accompanied by a progressive increase in the body-weight, greater than the increase in the weight of the fœtus and generative organs together; this is partly accounted for by the retention of tissue-fluids, and partly also by the improved general nutrition of the maternal tissues.

The Protein Metabolism.—A study of the nitrogen intake and output shows that during almost the whole period of pregnancy the mother is storing nitrogen at a rate considerably in excess of the nitrogen requirements of the fœtus, which are estimated at one gramme a day (representing three grammes of protein). Metabolism experiments on the pregnant woman are naturally extremely difficult to carry out, because of the length of the gestation period and the prolonged monotony of a standard diet. The most complete investigation was that of Hoffström, who kept a primigravida under continuous observation from the sixteenth week until the end of pregnancy. The total amount of nitrogen retained was 310 grammes, of which 101 grammes were reckoned as having been deviated to the fœtus and adnexa; the maternal organism completed the pregnancy, therefore, with a net gain of 209 grammes. This remarkable retention of nitrogen during pregnancy is probably a preparation for the period of lactation (Marshall).

The Excretion of Nitrogen during Pregnancy and its Distribution.—The diminished nitrogen output is manifested in the urine, the output by the fæces remaining constant. Not only is the total nitrogen of the urine diminished, but there is also an alteration in the nitrogen distribution; the percentage of urea nitrogen is relatively decreased and the percentage of ammonia nitrogen, the so-called 'ammonia co-efficient,' is relatively increased. The percentage of amino-acid nitrogen is also increased. Creatin also occurs in the urine of normal pregnant women on a creatin-free diet. These alterations in the nitrogen excretion were formerly the basis of the erroneous theory that pregnancy was accompanied by a faulty metabolism; the high ammonia nitrogen was interpreted as

indicating an acidosis and the high amino-acid nitrogen as a sign of hepatic insufficiency; and eclampsia, in which very high values for ammonia and amino-acid nitrogen may be found, was regarded as an exaggeration of this supposed faulty metabolism. Recent work has dispelled this theory, and has led to the more rational view that the modified nitrogen metabolism of normal pregnancy is physiological and not pathological. The high percentage of ammonia nitrogen is readily explained by the increased retention of nitrogen. In a non-pregnant woman the bulk of the urea excreted represents the waste or excess nitrogen not needed by the organism. During pregnancy increasing amounts of this waste nitrogen are being used up by the mother for her own tissues and for the fœtus; consequently the percentage of urea nitrogen falls, and if the absolute amount of ammonia nitrogen remains constant its relative amount is bound to be high. Moreover, it is now established that in eclampsia the still higher rise in the ammonia nitrogen is due chiefly to the fixation of ammonia by the large amounts of aceto-acetic and other organic acids which are always produced in the body in this disease.

The Carbohydrate Metabolism.—A pregnant woman requires a liberal carbohydrate diet, for the demands of the fœtus for glycogen are great. She is more liable therefore than the non-pregnant woman to get into a state of glycogen-starvation. There is a tendency to a glycogen deficiency in the liver, most pronounced in the early weeks of pregnancy, when the needs of the ovum for glycogen are great; to this Harding believes the acidosis and vomiting of early pregnancy are due. There is a great liability to alimentary glycosuria, but the blood-sugar does not rise above normal; about one-third of all pregnant women may be expected at one time or another to have this form of glycosuria.

Metabolism of Fats.—There is an increased absorption of fats from the intestine, especially towards the end of pregnancy, when the subcutaneous tissue of the fœtus receives an abundant supply. The presence of small quantities of acetone in the urine may be found at one time or another in almost all normally pregnant women, and large quantities appear on very slight provocation, such as a temporary period of starvation or vomiting. Acetone indicates a disturbed fat metabolism; it is formed by the decomposition of aceto-acetic and β-oxy-butyric acids, and these are intermediate products of the oxidation of fatty acids. In the normal organism acetone appears in the urine during starvation and when carbohydrates are withheld from the diet; in such circumstances the liver, having used up its store of glycogen, begins to draw on fats for a further supply, and acetone appears as the result of this abnormal fat metabolism. During pregnancy the store of liver

glycogen is more easily depleted by the demands of the fœtus, and abnormal fat metabolism of this nature is very liable to occur.

Metabolism of Minerals.—There is a diminished excretion of *calcium* by the urine, so that on a calcium-rich diet the mother shows a gain in calcium during pregnancy. The demands of the fœtus for calcium are great, especially during the last three months, and a store of calcium has to be laid up for the milk. If the diet is deficient in calcium, the teeth are apt to become brittle during pregnancy, and that rare disease, puerperal osteomalachia, may result from an extreme calcium deficiency.

Iron is required by the fœtus for the formation of hæmoglobin and nucleo-proteins. It is derived from the maternal hæmoglobin ; the ingestion and solution of maternal red blood corpuscles can be observed in the trophoblast. A large amount of iron is stored in the fœtal liver. This is a significant fact in the nutrition of infants, for there is no iron in milk, and the period during which milk is an adequate diet for the infant is limited by the reserve of iron the fœtus has stored during pregnancy. If the mother during pregnancy is kept on a diet rich in iron, the fœtus will store more iron than when the diet is poor in iron (Marshall).

Serum Reactions in Pregnancy.—A great advance in the study of the biology of pregnancy was hoped for from Abderhalden's discovery of a specific serum reaction for pregnancy, known as ' Abderhalden's test.'

This test is based upon the principle that the introduction into the blood of an organic foreign substance leads to the formation of a special ferment which will destroy it. Abderhalden's plan was to try to discover whether the blood of a pregnant woman contained a ferment capable of destroying placental protein.

The fact that fragments of chorionic epithelium enter the maternal blood vessels, and are carried to distant parts, has been already referred to. One of the first observers of the migration of fragments of syncytium into the blood-stream was Veit. His observations led him to conceive the idea that the presence of this substance in the blood might be deleterious, and might become the means of exciting the production of a protective body or antigen, the function of which would be to destroy the syncytium. To this hypothetical protective body he gave the name of *syncytiolysin.* Abderhalden desired to find out whether these fragments of fœtal epithelium are disposed of in the blood by a ferment.

The details of Abderhalden's test are very complicated. The isolation of the ferment itself being impracticable, his test aims at the detection of substances known to be end-products of the

process of proteolytic digestion of all kinds of proteins. His test has not withstood experimental and clinical criticism, and his views are no longer accepted.

The Diagnosis of Pregnancy

The limits of age within which pregnancy may occur are very wide. It is rare before puberty, and even more rare after the menopause. Yet authentic instances of pregnancy have been observed at the age of eight or nine years in girls, in whom menstruation had appeared abnormally early. And several authentic cases have also been recorded after the menopause, one of these being a woman of fifty-nine who had ceased to menstruate for nine years (Depasse). It may, however, be said that pregnancy is extremely uncommon before thirteen and after fifty.

The nomenclature of the duration of pregnancy is somewhat confusing. In this country it is usual to speak of nine calendar months as the period of gestation, but this in inexact. It is agreed that the average duration of pregnancy is from 274 to 280 days; neither of these periods represents precisely nine months, for the number of days in nine months is variable; but the latter does represent exactly ten times four weeks. It would avoid confusion to estimate the duration of pregnancy in lunar months or in weeks instead of in calendar months.

During the second half of pregnancy the presence of a fœtus in the uterus can be directly recognised by palpation and auscultation. During the first half this is impossible, and diagnosis then depends upon the careful observation of a certain series of *symptoms* (facts elicited from the patient), and *physical signs* (facts observed by the physician). The practical value of being able to recognise pregnancy at all periods is very great, and the subject therefore demands the most careful attention.

I. **Diagnosis of Pregnancy during the First Half.—Symptoms.**—Those met with during this period are amenorrhœa, morning sickness, irritability of the bladder, discomfort and swelling of the breasts, enlargement of the abdomen, and 'quickening.' It must be understood that not one of these symptoms occurring alone, nor even all of them occurring together, can be regarded as conclusive evidence of pregnancy. They allow of the 'presumptive diagnosis' of pregnancy, but a definite opinion should never be expressed in any case until a physical examination has been made. And further, until the tenth week has been reached, the changes in the uterus itself are not sufficiently definite to allow of a physical diagnosis being made unless the conditions are specially favourable.

Amenorrhœa.—Cessation of the menses is almost invariable in pregnancy; cases are said to occur in which regular menstruation continues for the first two or three months, but they

are extremely rare, when pathological bleeding can be excluded. Even in double uteri, menstruation ceases as a rule, although only one half of the organ is gravid. Irregular hæmorrhage from pathological causes is not uncommon in pregnant women, but this should not be confounded with menstruation. Sudden cessation of the menses in a healthy woman habitually regular, and not near the age of the menopause, affords a strong presumption of pregnancy. Amenorrhœa usually, though by no means invariably, continues during suckling, and it is also common in chlorosis, in hysteria, and in some forms of insanity. In addition to its value as a presumptive symptom of the existence of pregnancy, amenorrhœa affords the best means of estimating its duration. It is usual to reckon the beginning of pregnancy from the last regular menstrual period. This method is certainly fallacious, for pregnancy may occur during a period of amenorrhœa due to some other cause, such as suckling ; and it takes no account of the fact that the date of fruitful sexual intercourse does not necessarily correspond with the cessation of menstruation, but it is the best method which is available for the purpose. Sometimes, however, the duration of pregnancy must be estimated from other data, such as the size of the uterus.

It is not known why the presence of a developing ovum in the uterus causes the immediate arrest of menstruation. There is a certain amount of evidence that ovulation continues, or may continue, during pregnancy (see Superfœtation, p. 88), which makes the cessation of menstruation the more remarkable. It has been suggested that a body is produced during pregnancy which antagonises the internal ovarian secretion, and thus arrests the menstrual process. It is possible that such a body may be present also in the mammary secretion, which would account for the amenorrhœa of lactation. After the fourth month, when the decidual space has been obliterated, of course menstruation cannot occur.

Morning Sickness.—This symptom is by no means invariable in pregnancy. The great majority of primigravidæ suffer from it, but in subsequent pregnancies it is frequently absent. It usually appears at the beginning of the second month—*i.e.*, soon after the first suppressed period—and it varies greatly in severity. Some pregnant women are seized with nausea, ending in vomiting, immediately on rising or after their first meal ; the vomiting once over, there is no further discomfort nor any loss of appetite during the rest of the day. Others are subject to nausea, without vomiting, which may last for several hours and is more troublesome than the first-named variety. But in neither case is the general health affected, and the tongue remains clean. All gradations may be observed between this symptom and the serious disorder of pregnancy known as

hyperemesis (see p. 120). Morning sickness in either of these common forms usually lasts for only a few weeks, rarely for more than three months. The modern tendency is to regard it as a toxic symptom. It must be remembered that in chronic alcoholism morning sickness, sometimes associated with amenorrhœa and abdominal enlargement, may be met with apart from pregnancy ; but the tongue is furred, and the careful observer will detect other changes characteristic of this condition.

Irritability of the bladder, shown by frequency of micturition with some pain or discomfort, is usual during the second and third months, and is caused in part by the pressure of the heavy anteverted uterus, in part by the congestion of the mucosa of the bladder previously referred to (p. 69). After the third month, when the uterus rises above the pelvic brim and becomes more erect, the pressure is removed, and this symptom disappears or becomes alleviated.

Enlargement of the breasts is often noticed early by a primigravida, but *enlargement of the abdomen* usually does not become manifest to the patient until the uterus rises well above the pubes, and therefore seldom attracts attention until the close of the first half of pregnancy. A multipara, owing to the laxity of the abdominal wall, usually notices abdominal enlargement earlier than a primigravida.

Quickening.—This term in its ancient significance means ' coming to life,' and indicates that the mother has become aware of the existence of something which is alive and moving within her. The first movements of the fœtus which are felt by the mother sometimes produce a sensation of more or less severe nausea or faintness, and to this symptom the term ' quickening ' is applied. Many women do not experience it, and find it impossible to tell when the movements of the fœtus first become obvious to them, so gradual has been their development. When a definite history can be obtained, quickening is usually found to occur between the eighteenth and twentieth weeks. Fœtal movements continue until the end of pregnancy, and are chiefly important in the later months as an indication that the fœtus is alive. The mother continues to be conscious of these movements, as a rule, unless the fœtus dies.

Physical Signs.—During the first few weeks no changes occur which can be detected by clinical investigation, and unless the conditions are specially favourable the earliest period at which pregnancy can be diagnosed is the eighth week. We therefore take up the physical signs at this period.

Eighth Week.—The breasts of a primigravida may present recognisable indications of activity, but frequently they show no change until the following month. The cutaneous veins over and between the breasts are more noticeable. Some hypertrophy of the peripheral lobules of the glands, indicated

by a nodular feel and slight tenderness, may be apparent, while the areolar changes described on p. 65 may also be detected. Occasionally a little clear serum may be expressed by gently squeezing the base of the gland towards the nipple. In a multipara no importance can be attached to the existence of these signs, as they frequently persist in a gland which has previously passed through the period of functional activity associated with suckling, or even with pregnancy alone. Secretion is also sometimes found in the breasts of non-pregnant nulliparous women suffering from uterine disease, such as a fibroid tumour.

Examination of the abdomen at this period is of no value but *changes in the uterus* may be detected by a careful bi-manual examination. Softening of the lips of the os externum may be made out, but is not very marked, and may be mistaken by the student for the condition clinically known as 'erosion'; examination with a speculum will clear up this difficulty, unless erosion of the cervix and pregnancy co-exist. If the abdominal wall is thin and lax, the body of the uterus can be taken between the fingers of the two hands, and its increased size, almost globular shape, and soft consistence detected. Another important change known as Hegar's sign must also be looked for.

Hegar's sign is the result of certain anatomical conditions which are characteristic of the second and third months of pregnancy. It will be recollected that at this period the ovum does not completely occupy the uterine cavity, an empty space being left in the lower part, called the decidual space. At this period also the walls of the uterus have become distinctly softened, and perhaps somewhat thinned. The body of the uterus is therefore in its upper part soft and distended by the ovum, in its lower part soft and empty. The lower part is consequently unusually compressible by the fingers in bi-manual examination, and Hegar's sign consists in the recognition of this unusual degree of compressibility. To obtain it, the uterus should be anteverted, although even in the retroverted position it can be elicited in a modified manner. Bi-manual examination is made with the patient lying on her back, the shoulders slightly raised, and the knees well flexed. Two fingers of the right hand are introduced into the vagina and placed immediately in front of the cervix; the left hand is placed over the suprapubic region. The uterus is then pushed upwards from the vagina towards the abdominal wall until it can be distinctly felt by the left hand. The fingers of the left hand are now passed over the posterior surface of the uterus, and when the two hands work together the lower part of the uterine body can be compressed between them (Fig. 53). Two points will then be noticed: first, the ease with which the fingers can be approximated and the walls of the uterus compressed; and, secondly,

the tense elastic consistence of the upper part of the uterus, which forms a marked contrast to the lower part. When the uterus is retroverted, the compressibility of the lower part can be made out with a finger in the rectum and the other hand on the abdominal wall; but the upper part of the body is not so easily accessible as in the position of anteversion, consequently

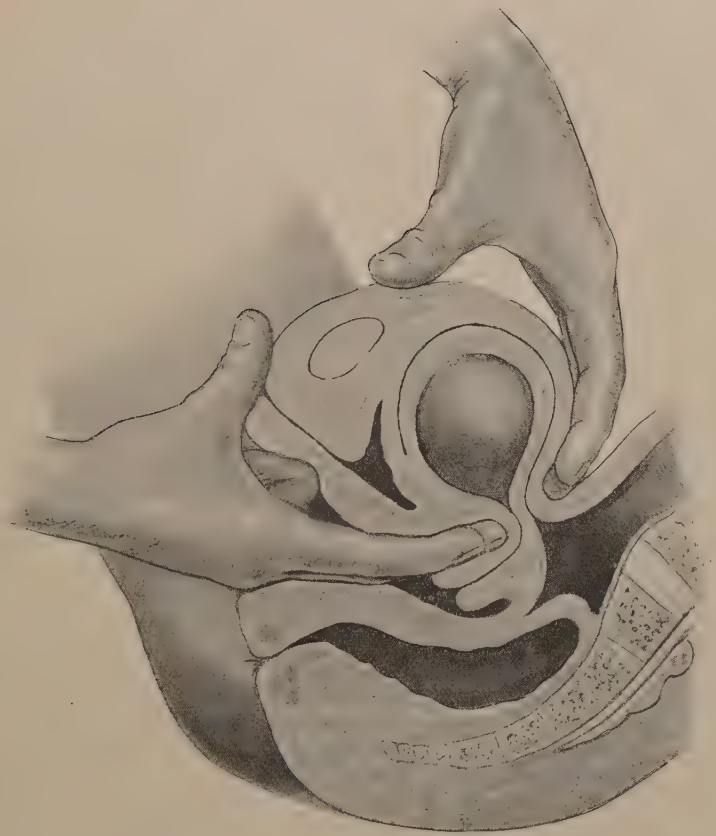


Fig. 53.—Schematic Representation of Hegar's Sign. (After Hegar.)

the contrast between the upper and lower parts cannot well be made out. A certain amount of skill and experience in gynæcological examination is necessary for the recognition of this sign, but its value is very great when clearly perceived; the examination should be brief and gentle lest the attachments of the ovum be disturbed.

To sum up, it may be said that pregnancy at the eighth week

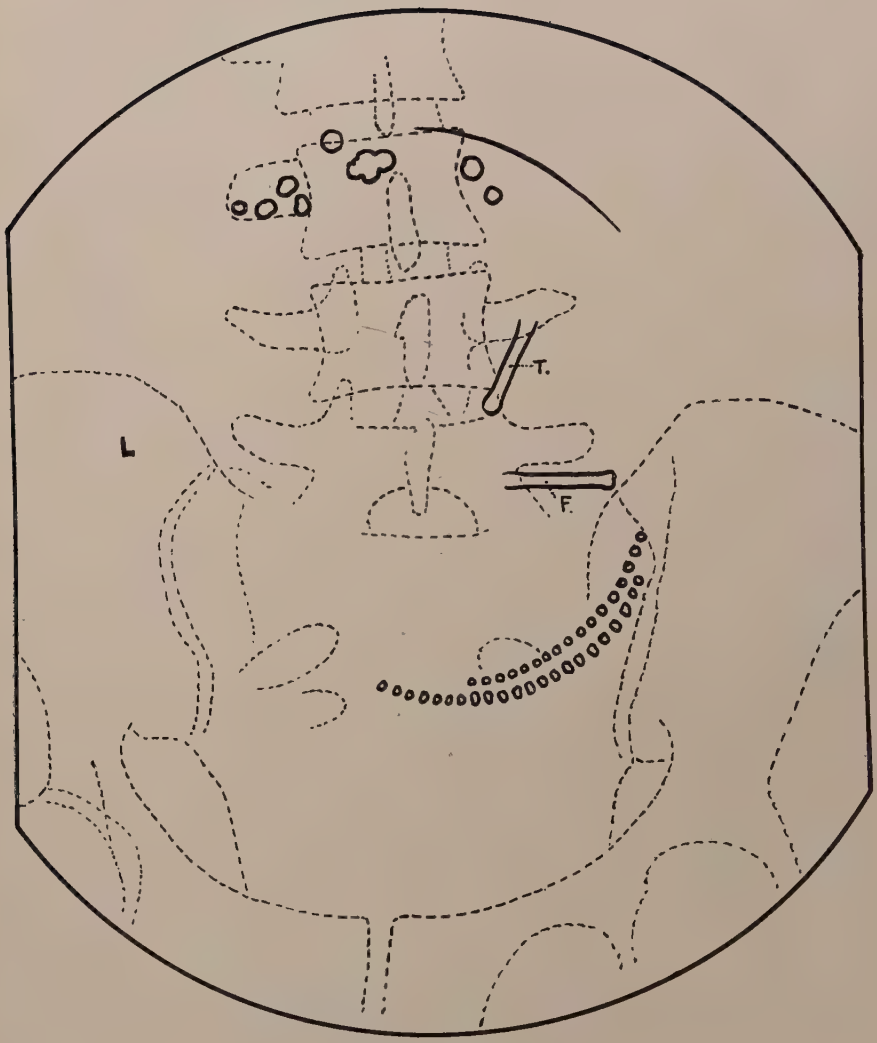
can be diagnosed from the conjunction of the following series of symptoms and physical signs :

Symptoms.	*Signs.*
1. Amenorrhœa.	1. Slight breast changes (in a primigravida).
2. Morning sickness.	2. Lips of os externum softened.
3. Irritability of bladder.	3. Uterine body enlarged, softened, nearly globular in shape.
	4. Hegar's sign.

Sixteenth Week.—Amenorrhœa continues, but morning sickness and urinary symptoms have usually disappeared by this time. It is about this period that quickening is to be expected. The enlargement of the breasts has become quite obvious to the patient if she is a primigravida, but abdominal enlargement may not yet have attracted her attention.

Hypertrophy, increased pigmentation, and presence of secretion in the breasts can now, as a general rule, be made out. The linea nigra will be quite obvious in dark-complexioned women. The uterus is large enough to be felt rising to a height of about 2 inches above the level of the symphysis pubis. It forms an elastic, somewhat ill-defined, mesial abdominal swelling, with a convex upper border. The characteristic dull violet coloration of the vulval mucous membrane is now recognisable, but its extent and intensity are variable. The cervix shows more extensive softening, and at this period forms one of the most characteristic and easily recognisable features of pregnancy. If exposed with a speculum the same violet coloration will be noticed as at the vulva. Pulsating vessels can often be felt at the sides of and behind the cervix—the enlarged vaginal arteries. The abdominal swelling can be recognised as the uterus by bi-manual examination ; its shape is now passing from globular to pyriform ; its consistence is intermediate between the hardness of a solid mass and the lax softness of a cyst, and is usually described as ' elastic ' ; but some experience is required to detect with confidence these varieties of consistence. Hegar's sign can no longer be made out. Two other signs of great importance can often be recognised at this period in the uterus—viz., *uterine contractions* and *internal ballottement.*

The fact that the gravid uterus undergoes *contractions* has been already referred to ; they are not recognisable clinically much earlier than the period under consideration, but it is possible that they exist in some form from the beginning of pregnancy. They are feeble contractions, and as detected at the end of the fourth month they merely render the uterus a little firmer and better defined in outline. Care and a prolonged *bi-manual* examination are required for their detection, for the intervals between them may be considerable ; they sometimes appear to be increased by manipulating the uterus. If the



GUIDE TO PLATE I.

The fœtal spine is lying across maternal sacrum. F. Femur. T. Tibia. The shadows lying across maternal third lumbar vertebra are calcified lymphatic glands.

PLATE I.

Radiograph of Uterus in Early Pregnancy. Duration of pregnancy was sixteen weeks. The uterus contained several small fibromyomata. The spine and one leg of the fœtus are clearly seen. The upper border of the uterus is faintly seen. (Radiograph by Dr. M. H. Jupe, The London Hospital.)

[*To face p.* 79.

abdominal wall is thick or rigid, or the patient intolerant of the examination, this sign cannot be made out, and no importance must be attached to a failure to elicit it ; but its positive value is considerable. It sometimes occurs, however, apart from pregnancy, in soft fibroid tumours, and has been recognised in the enlarged uterus in cases of extra-uterine gestation. Sometimes partial or unequal contractions occur affecting portions only of the uterus ; as a result the shape of the uterus may be distorted and its consistence may appear to be different in different parts. After an interval it resumes its normal shape and uniform consistence.

Internal ballottement consists in the detection in the uterus of a movable solid body surrounded by fluid. If during a bi-manual examination the fœtus should chance to lie upon the lower part of the anterior uterine wall, the fingers, sharply pressed into the anterior fornix, will displace it upwards through the amniotic fluid, and the sensation of its disappearance will be felt ; if the fingers are kept in position a slight impact may be felt a moment later, indicating its return to its original position. The return is often missed, but the displacement of the fœtus can frequently be detected. The fœtus, however, often occupies a position where it is out of reach of the fingers on vaginal examination, and this sign cannot then be elicited. It is more easily obtained in the erect than in the supine position. It will be remembered that at this period the size of the fœtus is small in comparison with that of the uterus.

Examination by the X-rays in difficult and complicated cases is extremely useful. A radiogram should reveal the fœtal skeleton by the sixteenth week (Plate I), and thus constitutes the *earliest positive sign of pregnancy* (see p. 80).

Pregnancy at the sixteenth week can therefore be diagnosed from the following :

Symptoms.	*Signs.*
1. Amenorrhœa.	1. Active breast changes.
2. Quickening.	2. Linea nigra ; elastic hypogastric swelling (uterus).
3. History of recent morning sickness.	3. Cervix softened.
	4. Uterine contractions, internal ballottement.
	5. Revelation of the fœtal skeleton by the X-rays.

II. **Diagnosis of Pregnancy during the Second Half.—Symptoms.**—The symptoms during the second half of pregnancy are of little diagnostic importance, since unmistakable evidence is furnished by the physical signs. Amenorrhœa continues ; a good deal of mammary discomfort is often experienced by a primigravida, owing chiefly to the increased weight of the enlarged glands. Towards the end of this period symptoms of

increased intra-abdominal pressure appear, such as œdema of the feet and cramps in the lower extremities, varicose veins in the legs and vulva, and sometimes, from upward pressure on the diaphragm, palpitations and dyspnœa. About two to three weeks before the onset of labour these symptoms all undergo a somewhat abrupt amelioration, popularly known as the 'lightening'; this is due to descent of the presenting part of the fœtus into the pelvic brim, and consequent relief of intra-abdominal pressure.

Physical Signs.—*Twenty-fourth Week* (*end of Sixth Calendar Month*). — From this date onwards three *positive signs of pregnancy* can be detected by palpation and auscultation. They are (1) hearing and counting the fœtal heart, (2) perceiving the fœtal movements, (3) palpating the outlines of the fœtus. The fourth positive sign — viz., detection of the fœtus by the X-rays, is rendered all the easier by the advancing ossification of the fœtal skeleton. If any one of these can be obtained, the diagnosis of pregnancy is certain.

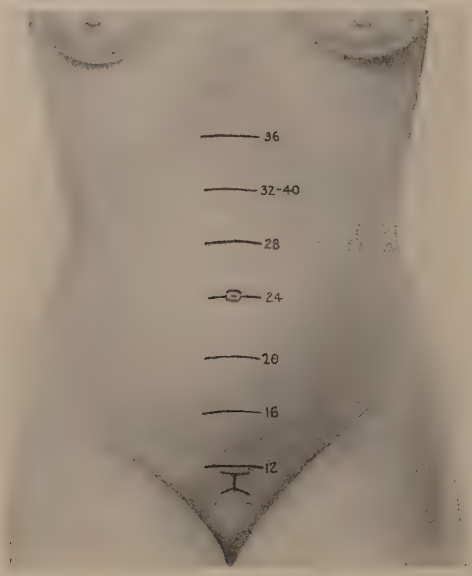


Fig. 54.—Diagram of the level of the fundus uteri at the different weeks of pregnancy.

Breast Changes. — Hyperthropy of the mammæ is now unmistakable; secretion can be freely expressed; pigmentary alveolar changes have become intensified.

Abdomen.—Protuberance of the lower half of the abdomen is now clearly visible, and a few recent striæ may be observed below the level of the umbilicus; the linea nigra in dark women is pronounced. On palpation the fundus of the uterus will be found at or slightly above the upper border of the umbilicus (Fig. 54). The uterus is distinctly pyriform in shape, and usually extends further to the right than to the left of the mesial plane—*right lateral obliquity*. Occasionally the obliquity is to the left, but the uterus is seldom exactly mesial. Its general consistence is elastic, but it does not yield a fluid thrill.

Contractions can usually be felt when it is gently palpated with the hands for two or three minutes. From the period when the fundus becomes palpable above the pubes, it rises, when developing normally, a little less than ½ inch a week.

In addition certain other signs may be detected on abdominal examination which are not found at earlier periods ; these are, on palpation, *external ballottement* and *spontaneous fœtal movements :* and on auscultation the *fœtal heart-sounds* and the *uterine souffle.*

At the twenty-fourth week, the fœtus, though large enough to be readily felt on abdominal palpation, moves freely, for it is still small in comparison with the size of the uterine cavity. The palms of both hands should be gently laid over the uterus, and while one hand is used to steady it, the fingers of the other hand make a series of quick but gentle impacts upon it ; the whole anterior surface and sides of the uterus are gone over in this way. At some part or other the fingers will come down upon the body or a limb of the fœtus ; the latter immediately recedes before the impact, but gives a distinct momentary sense of contact with a freely movable body. This is called *external ballottement.* Sometimes the fœtus can be displaced in this way across the uterus, and thus, as it were, tossed from one hand to the other. While using the hands in this manner *spontaneous movement* of some part of the fœtus, probably a limb, will often be detected, proving not only that there is a fœtus present, but that it is alive. Care is required in eliciting these signs, but they are of great diagnostic value. As pregnancy advances the spontaneous movements made by the fœtus become much more manifest, and during the last six or eight weeks they are felt by the mother as energetic and even violent movements from which she is not free for more than a few hours at a time, and which often disturb sleep. Moving freely in its bag of liquor amnii, the fœtus thus takes exercise, which is no doubt of importance in the development of the muscular system. The principal movements are made by the limbs, but movements of the trunk also occur resulting in changes of ' position ' and ' presentation ' (see p. 253).

Uterine Souffle.—From the middle of pregnancy onwards, a soft, blowing, systolic murmur, synchronous with the mother's pulse, can usually be heard on auscultation of the gravid uterus. It is best heard at the lowest part of the lateral borders, but may sometimes be loud enough to be audible over a large part of the anterior surface of the uterus. In seeking this sign the uterus should be steadied with one hand, and the stethoscope pressed firmly upon it ; while listening to the sound the mother's pulse, with which it is synchronous, should be felt at the wrist. The uterine souffle is produced in the greatly enlarged uterine arteries, which, it will be remembered, reach the lateral borders

of the organ from the broad ligaments at the level of the internal os. Apart from pregnancy, it may be heard in large fibroid tumours of the uterus.

Fœtal Heart.—The recognition of the sounds of the fœtal heart is the most conclusive of all the clinical signs of pregnancy ; not only is it important in diagnosis, but during labour it affords valuable information, and the student should lose no opportunity of becoming familiar with it. The fœtal heart can usually be heard by the twenty-fourth week, but the further pregnancy advances beyond this, the more easily is it detected. Its localisation at this period is variable, and the whole anterior surface of the uterus must often be carefully searched before it can be found. Some experience in auscultation is of course necessary ; but if opportunities of learning this sign in pregnant women at term have been previously made use of, its recognition at this period of pregnancy will be greatly facilitated. At the sixth month the fœtal heart-sounds resemble the feeble or distant ticking of a watch ; they are much more rapid than the beats of the mother's pulse, which should always be simultaneously counted as a control, and they differ absolutely in character from the uterine souffle. When for any reason the maternal pulse rate is above 100, it is essential that a definite difference in rate between the maternal pulse and what is taken for the fœtal heart should be clearly made out, for sounds may be transmitted from the aorta which will be misunderstood unless this precaution be taken. At the sixth month the fœtal heart beats from 140 to 160 times a minute, and it is therefore difficult to count. At *term* the average rate is from 120 to 140, but even wider limits than these are possible ; only when the rate falls below 100, or rises above 160, can it be said to indicate danger to the fœtus. The fœtal heart-rate is not a reliable indication of sex. It is sometimes stated that the weight of the fœtus affects the heart-rate, and that the larger the fœtus the slower is the rate ; but observations show that there is no definite relation between weight and heart-rate.

In connection with the fœtal heart-sounds the *funic souffle* must be mentioned. It sometimes happens in auscultating the gravid uterus that a loop of the umbilical cord lies immediately beneath the stethoscope, and being subjected to slight compression, either by its position in the uterus or by the instrument, a faint, rapid, blowing murmur is produced, which is synchronous with the fœtal heart-sounds. It is seldom detected and, as it requires accidentally favourable circumstances for its production, it is of no practical importance.

The *vaginal walls* at this period are distinctly softened ; blue discoloration and softening of the cervix are more distinctly recognisable than at earlier periods. Since abdominal examination yields positive signs of pregnancy, from this period

onwards vaginal examination is unimportant for purposes of diagnosis.

Thirty-sixth week.—The shape of the abdomen and the size of the uterus are indicated in Fig. 54. The individual parts of the body of the fœtus can now be recognised by abdominal palpation, and the position of the head, back, and limbs localised. This, however, is of little importance in the diagnosis of *pregnancy*, but attention will be again directed to it in the section dealing with labour (see p. 277). About the thirty-sixth week the uterus attains its greatest height in the abdomen, extending nearly to the xiphoid cartilage, and the maximum abdominal girth averages 32 inches; during the last fortnight of pregnancy it may sink to a point midway between the umbilicus and the xiphoid cartilage, and the shape of the abdomen is in consequence a little altered (Fig. 54). Numerous recent striæ are found below the umbilicus, which is now flat or slightly everted.

The diagnostic value of X-rays.—In the diagnosis of pregnancy a radiogram may be extremely useful. Parts of the fœtal skeleton can be shown by the sixteenth week even under adverse conditions (Plate I), while under favourable conditions they may be revealed even earlier, provided a correct technique and an up-to-date apparatus are used. This fact is important in the differential diagnosis of early pregnancy, for the absence of a shadow is proof that the uterus does not contain a fœtus; the assistance of the radiologist is therefore sought chiefly when a vesicular mole is suspected, or when pregnancy is complicated by fibroids, or when the possibility of pregnancy is denied. At full term a radiogram can be relied upon to determine the presentation and lie of the fœtus when ordinary methods have failed to do so; this is particularly applicable to hydramnios, to multiple pregnancy (Plate II) and to breech presentation in a primigravida (Plate III). When Cæsarean section is contemplated in cases where the palpatory findings or the menstrual data are vague, a radiogram of the uterine contents is advisable, with the object of avoiding the tragedy of delivering premature twins or a monster; anencephaly is easily demonstrable by the radiologist. The degree of ossification of the bones will give some indication of fœtal age; the astragalus and os calcis can be seen after the twenty-eighth week, and the demonstration of the ossific centre in the lower femoral epiphysis suggests maturity. It is generally agreed that there is no risk to mother or fœtus with the modern apparatus, since the exposure does not last more than a few seconds. At term the exposure has necessarily to be longer than in early pregnancy and the radiologist's chief difficulty is that late in pregnancy the mother is less able to hold her breath, and the fœtal movements are more lively.

Determination of the Period to which Pregnancy has advanced.—This is sometimes a matter of considerable difficulty, yet its

practical importance is great. The most reliable guide is the calculation of the interval which has elapsed since the last menstrual period. Where these data cannot be obtained the date at which quickening occurred may be obtainable, and this may be taken as about the eighteenth week. In the absence of both these guides, the height of the uterus above the pubes is the only other criterion of calculation. This is necessarily inexact and variable, and in estimating pregnancy by this method there are several obvious sources of fallacy to be borne in mind. Thus there are individual differences in the thickness of the abdominal parietes, the amount of liquor amnii, the size of the fœtus, and the stature of the mother. The size of the uterus is dependent to a great extent upon the amount of liquor amnii which is present ; deficiency is associated with an unduly small, excess with an unduly large, uterus. In twin pregnancy also the uterus is unduly large. Certain conditions make the uterus *apparently* larger than it should be ; thus contraction of the pelvis may prevent the fœtus from sinking into the pelvic brim towards the end of pregnancy, and so occasion an increased height of the uterus ; a tumour lying in the pelvis would produce a similar effect. The most useful rule is that worked out by Macdonald, who found that after the twenty-sixth week the height of the fundus above the symphysis in centimetres, divided by 3·5, gives the number of *lunar* months of pregnancy. Thus, if the height is 30 cm. (12 inches), the period of pregnancy is eight and a half months = thirty-four weeks.

Differential Diagnosis of Pregnancy.—To consider all the varieties of abdominal swellings which may be mistaken for a pregnant uterus would require a wide excursion into the domain of gynæcology, and cannot be undertaken here. It is, however, necessary to recall the occasional occurrence of a curious imitation of pregnancy of hysterical origin which is known as *Pseudocyesis* (spurious pregnancy). It occurs in women of neurotic temperament, especially when associated with either dread of pregnancy, as in the unmarried, or desire to become pregnant, as in sterile married women. Such women present the symptoms of amenorrhœa, morning sickness, and progressive abdominal enlargement ; they quicken, and feel what they regard as continual and active fœtal movements ; and at the appointed time they suffer from severe and prolonged abdominal pains which they are convinced represent labour, but which of course have no result. On physical examination certain signs of mammary activity may be found, which are undoubtedly deceptive. The abdominal enlargement, however, will seldom deceive any but the most inexperienced practitioner ; none of the positive signs of pregnancy can be detected either by abdominal or vaginal examination ; and if an anæsthetic is administered the abdomen becomes flattened

(unless the patient is very obese), and bi-manual examination will demonstrate that the uterus is not enlarged.

Abdominal Swellings complicating Pregnancy.—The diagnosis of the existence of pregnancy, or of its duration, is sometimes rendered very difficult by the presence of such conditions as an ovarian cyst, a fibroid tumour, or ascites ; the latter may be of malignant origin. In cases of retroversion of the gravid uterus the presence of the over-distended bladder may give rise to similar difficulties (p. 126). In all of these conditions an abdominal swelling of a size disproportionate to the period of amenorrhœa will be present. The first step in the diagnosis is to establish confirmatory signs of pregnancy, such as heart changes, softening of the cervix, or blue discoloration of the mucous membranes of the vulva. This step being taken, the next is to determine whether the abdominal swelling is single or whether there are two, and in the latter case to differentiate their characters. The signs by which the gravid uterus can best be recognised are (1) intermittent contractions ; (2) ballottement ; (3) auscultation of the fœtal heart. The detection of any one of these signs in a part of the swelling shows it to be the gravid uterus. Ovarian cysts are usually more lax than the uterus, and often yield a fluid thrill ; fibroids are usually firmer and harder, and only exceptionally do they contain fluid. Ascitic fluid can be recognised by its varying distribution on changes of position and the ease with which a fluid thrill in all directions can be obtained. When the above methods fail to convince, a radiogram will settle the diagnosis.

The Normal Duration of Pregnancy.—Only an approximate estimate of the duration of any pregnancy can as a rule be formed. The moment at which pregnancy begins, by fertilisation of the ovum, cannot be determined, and consequently there is abundant room for error. The best estimate possible is that in which pregnancy can be reckoned from a single coitus, and, estimated in this way, the average duration of pregnancy appears to be 274 days. But fertilisation of the ovum does not immediately follow coitus in all cases, and we know that spermatozoa can retain their vitality in the Fallopian tubes for from fourteen to twenty-one days. Therefore even this estimate is fallacious. For practical purposes the first day of the last menstrual period must be taken as the point from which calculation is based. Forty weeks (280 days) may be allowed as the average interval which elapses between the beginning of the last period and the occurrence of labour, which appears to show that as a rule pregnancy begins most often during the week following the cessation of menstruation. This period of 280 days from the beginning of menstruation must be regarded as an approximate estimate only, the limit of probability ranging from the 274th to the 280th day (see also p. 207).

Prolongation of Pregnancy.—When the calculated duration of pregnancy exceeds 300 days (from cessation of menstruation) the condition is one of *post-maturity*. It is not very uncommon to find pregnancy prolonged to eleven lunar months—forty-four weeks (*i.e.*, 308 days) or thereabouts. An instance has been recorded by Von Winckel in which the duration was calculated to be 322 days. Clinical estimates of post-maturity can be controlled after delivery by the length and weight of the fœtus, which considerably exceed the normal. An instance came under the writers' notice in 1912 in which the fœtus weighed 14½ pounds and died during delivery, pregnancy having continued three weeks beyond the calculated date.

Multiple Pregnancy.

Although it is the rule in the human species for only one fœtus to be born at a birth, twin pregnancy occurs in the proportion of about 1–80 to 1–90 births ; but its frequency varies greatly in different countries. Heredity is the only known factor in causation, and the influence of this factor is very marked. Triplets are very much less frequent than twins, and are estimated to occur only once in 6,000 to 10,000 pregnancies. Quadruplets are still rarer ; although they may reach the period of viability and be born alive, they seldom all survive. Quintuple pregnancy is extremely rare, and always ends in abortion. An instance has been recorded by Nijhoff, who in addition succeeded in collecting twenty-seven recorded cases of quintuplets in obstetrical literature between 1694 and 1900, which sufficiently indicates the great rarity of the condition.

Twin Pregnancy may result from the simultaneous fertilisation of two ova, or from the fertilisation of a single ovum ; the former are called *binovular*, the latter *uniovular* twins. *Binovular* twins may result from the fertilisation of an ovum from two distinct Graafian follicles, or of two ova from a single follicle. Sometimes two follicles ripen simultaneously in one ovary. The ova may both develop in the normal uterus, or one in each half of a double uterus ; or one in the uterus, the other in a Fallopian tube ; or one in each Fallopian tube. They are much more frequent than uniovular twins, the proportion being about 6 to 1. We can only speculate upon the manner in which *uniovular* twins are produced. The ovum may possess two germinal vesicles (nuclei) ; or two embryonic areas may be formed if an ovum is fertilised by more than one spermatozoon ; or the single embryonic area may divide, each half producing a fœtus. Differences between binovular and uniovular twins are to be found in sex, in development, and in the formation of the placenta and membranes. In each variety hydramnios of one ovum may occur, the other remaining normal.

Sex.—Uniovular twins are always of the same sex ; binovular

twins may be of the same or of different sex, the latter being rather more common than the former. Therefore twins of the same sex may be developed either from one or two ova, while those of different sex are necessarily binovular. Including all cases, twins are more commonly of the same sex (boy and boy, or girl and girl) than of different sex, and, as in single pregnancy, the number of boys slightly exceeds that of girls. *Development.*—A twin fœtus is usually somewhat smaller and lighter than a single fœtus ; the two are sometimes unequal in size, and differences of 1 to $1\frac{1}{2}$ pounds in weight may be met with. One may be normally developed, the other malformed ; or one may perish during pregnancy while the other develops till term. Malformations are common with uniovular twins, and certain rare forms of monstrosity only occur in such fœtuses. *Placenta*

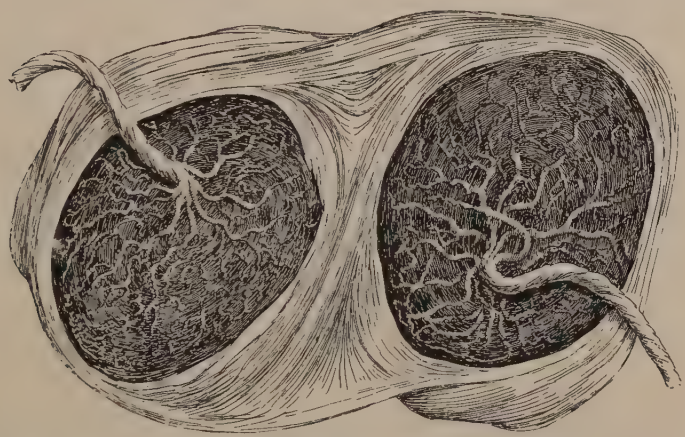


Fig. 55.—Twin Placentæ and Membranes of Binovular Development (Ribemont-Dessaignes and Lepage.)

and Membranes.—With *binovular* twins the two ova may develop quite separately from each other, so that two separate placentæ and two complete sets of membranes are formed (Fig. 55). If, however, the two ova should be implanted close to each other in the uterus, the two placentæ will be in contact, and they may even become more or less firmly united by their adjacent edges, forming apparently a single organ. The decidua capsularis then forms a single envelope for the two ova, so that the two chorions are apposed where the ova come in contact. The circulatory system of each fœtus is quite distinct, even when the placentæ are thus united ; anastomoses never occur. With *uniovular* twins a single placenta and chorion are formed ; the amnion may be double (Fig. 57) or single (Fig. 56), the septum in the former being frequently incomplete at term. The umbilical cords are distinct. Free anastomoses always exist in

the placenta between the circulatory systems of the two fœtuses, and according to Schatz this is usually arterial, but may rarely be venous; venous anastomoses (placental) are superficial, arterial anastomoses are deep. As a result of these anastomoses blood from one fœtus finds its way into the circulation of the other—an important factor in the production of certain fœtal monstrosities and of *hydramnios*. One fœtus may also have at its disposal a larger placental area than the other, the one thus favoured being always the more fully grown. Such monstrosities as the thoracopagus are only possible in twins of uniovular development.

Observations upon the development of the amnion make it probable that twin fœtuses with a single amnion or with united

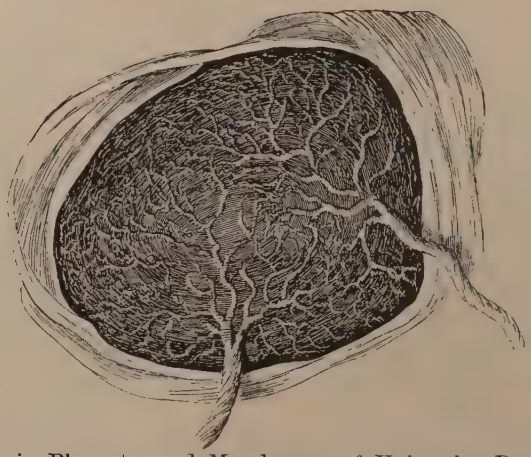


Fig. 56.—Twin Placentæ and Membranes of Uniovular Development. (Ribemont-Dessaignes and Lepage.)

umbilical cords are developed by division of an originally single embryonic area, for the amniotic vesicle is clearly seen at a time when the embryonic area is represented merely by a thickened layer of ectodermal cells.

Superfecundation and Superfœtation.—If two ova are fertilised simultaneously, twin pregnancy results; sometimes a second ovum is fertilised while the first is developing, and to this condition the above terms are applied. If the interval between the two separate acts of fertilisation is a short one, the condition is called *superfecundation:* instances are well known to occur in lower animals, as when, for example, a mare gives birth to a horse and a mule at a single labour, having been covered at about the same time by a stallion and an ass. Proof of its occurrence is difficult in the human subject, and unless the fœtuses are of different colour it is indistinguishable from bin-

ovular twin pregnancy. It is easy to conceive of such an occurrence in the two Fallopian tubes. When the interval between the two acts of fertilisation is considerable, amounting to weeks or even months, the condition is called *superfœtation*. If ovulation continues during early pregnancy, there is no insuperable obstacle to the fertilisation of a second ovum and its lodgment in the uterine cavity, so long as the decidual space persists—*i.e.*, up to the fourth month. The result of this occurrence

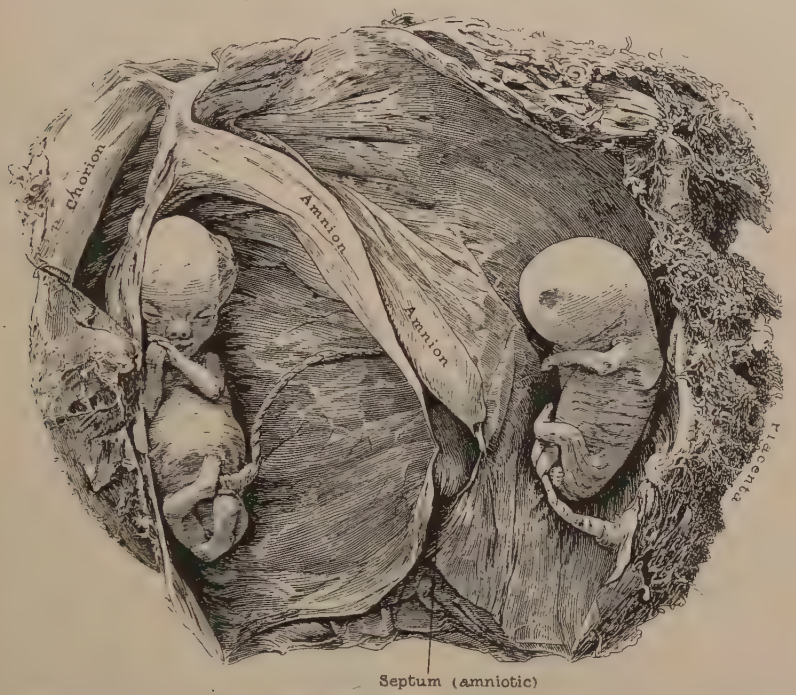


FIG. 57.—Twin Pregnancy (probably uniovular): Abortion at Third to Fourth Month. The Amnion is double. (Charing Cross Hospital Museum.)

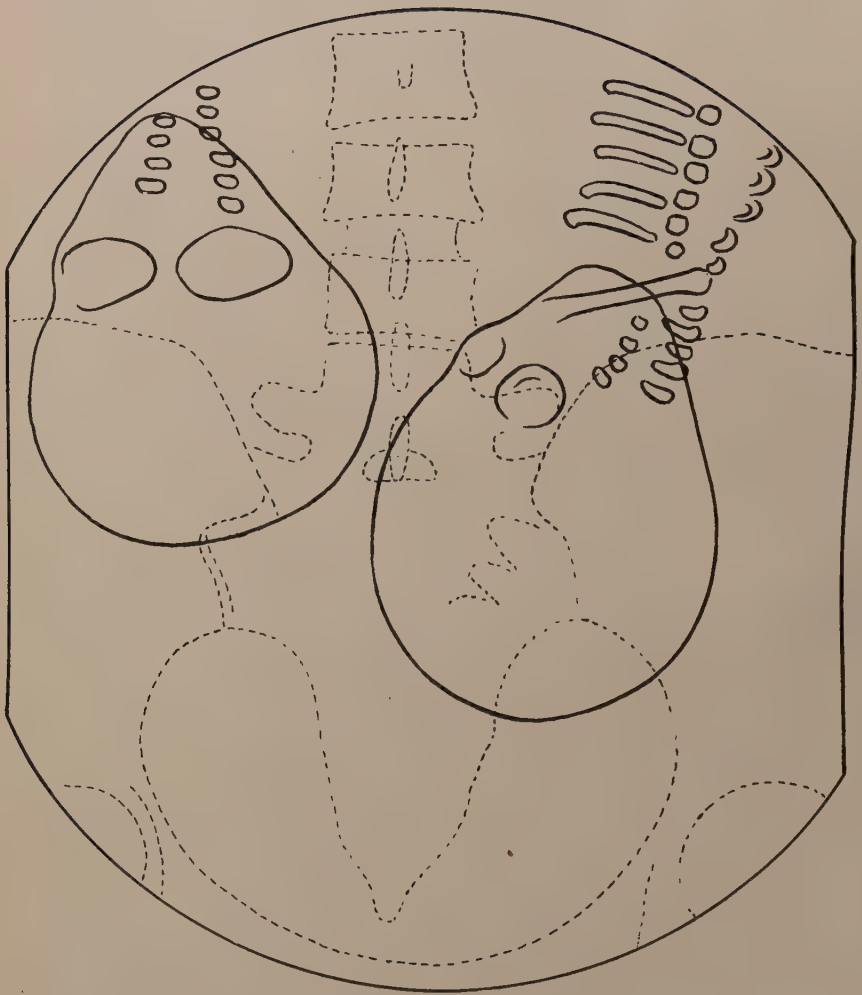
Note that torsion has occurred in the umbilical cords.

would be the presence in the uterus of two fœtuses of widely different stages of development. A double uterus offers an easy explanation of such an occurrence. Superfœtation may end in abortion, both ova being thrown off before they are viable; or one ovum developing to full time, a mature fœtus and a premature one may be born at the same labour; or the birth of a mature fœtus may be followed after an interval of a few weeks by the birth of a second equally mature. The occurrence of superfœtation in the human subject has never yet been convincingly demonstrated.

Clinical Course and Diagnosis of Twin Pregnancy.—Diagnosis is impossible during the early months ; it can only be established by the detection in the uterus of two fœtuses. The uterus is always larger than normal, but undue enlargement must not be attributed to twins without more definite evidence. A sure sign is the recognition of two distinct fœtal hearts, beating at different rates. This sign cannot be detected until after the sixth month, and unusual care must be exercised in establishing the difference in rate between the two hearts. It is not sufficient for the observer to find fœtal heart-sounds audible at two different parts of the uterus, for rapid changes in the position of the fœtus may occur, and thus lead to mistakes. Two observers auscultating at the same moment should simultaneously count the fœtal heart-sounds to which they are listening, and if a definite difference of, say, ten beats per minute is detected between them, twins may safely be diagnosed. This difference in rate is believed to depend upon inequality in size of the fœtuses ; but if there is only slight inequality there will be no recognisable difference in rate. Towards the end of pregnancy the presence of a fœtal head may sometimes be definitely recognised both at the fundus and in the lower uterine segment. Twin pregnancy is frequently complicated with hydramnios, and this condition greatly increases the difficulty of diagnosis by obscuring the results both of palpation and auscultation. A radiogram affords, of course, the most convincing evidence of twin pregnancy (Plate II). There is also an increased risk of the development of toxæmic conditions in multiple pregnancy.

Fig. 58.—Mummified Fœtus (Fœtus papyraceus).
(Charing Cross Hospital Museum.)

Twin pregnancy tends to come to an end a little before term ; that is to say, labour is premature. Owing to the undue size of



Guide to Plate II.

PLATE II.

Radiograph showing Twins, at Full Term of Pregnancy. Both fœtuses are presenting by the vertex; both heads are above the brim. (Radiograph by Dr. M. H. Jupe, The London Hospital.)

[*To face p.* 90.

the uterus, pressure symptoms may be unusually troublesome, and morning sickness is said to be often unusually severe. Sometimes the uterus is not much larger than normal; this may be due to the fact that one fœtus has perished *in utero*. When this occurs the fluid in the dead ovum is absorbed, and the body of the fœtus compressed between the growing ovum and the uterine wall, and its tissues altered by absorption of fluid; the result is the birth of a curiously flattened mummified fœtus, to which the term *fœtus papyraceus* or *fœtus compressus* has been

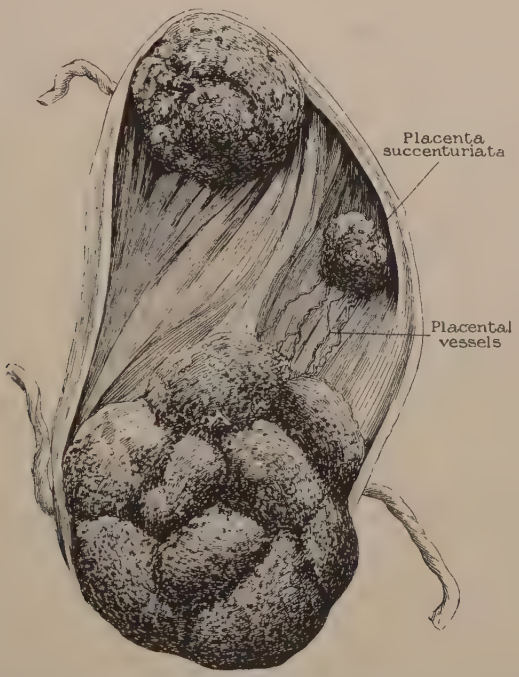


FIG. 59.—Triplet Placenta developed from Two Ova, and showing the Abnormality of Placenta succenturiata. (Ribemont-Dessaignes and Lepage.)

applied (Fig. 58). The placenta of this fœtus offers a striking contrast with that of the living one; it is pale, and completely consolidated on section, no trace of the normal spongy tissue remaining. Microscopically it presents the appearance characteristic of advanced infarction and fatty degeneration.

Triplets result from the fertilisation of three separate ova or from the conjunction of uniovular twins with an ordinary single fœtus. In the former case three distinct placentæ and sets of membranes are found; in the latter and commoner case there are two placentæ of very unequal size, the larger having two

cords attached, and corresponding to the placenta of uniovular twins (Fig. 59). The single fœtus may have a distinct set of membranes. Triplets are more commonly of different sex than all of the same sex, but boys predominate considerably in number. Diagnosis is very difficult, and labour usually comes on prematurely. The survival of all three infants is rare.

The Management of Normal Pregnancy.

Although pregnancy is a normal bodily function, and should not be regarded as a malady, it is undoubtedly attended by many risks, and it involves a considerable strain upon certain organs, which they may be unable to bear unless care is taken to maintain them in a condition of normal physiological activity. This is especially the case in a first pregnancy ; afterwards the organism appears to be able to bear with less disturbance the altered conditions accompanying the pregnant state. The functions which require the closest attention are those of digestion and excretion, for their failure may have the most serious consequences both to the mother and the fœtus. Diet is a matter of some importance during pregnancy. Generally speaking, the appetite is increased above what is normal to the individual, and over-feeding is not called for when the conditions are normal. Dietetic fancies quite foreign to the usual tastes of the individual are sometimes met with (the so-called ' longings '), and these need not be discouraged if the direction they take is not unwholesome. Food should be simple and plainly cooked ; meat should be taken only in moderate quantities, and sugar or sugar-containing foods should be reduced even more than animal proteins. Fluids should be taken freely, and the value of milk in such a diet is sufficiently obvious. Alkaline natural waters, such as those of Vichy or Contrexéville, are useful. The waste of phosphates and chlorides which occurs during pregnancy should be borne in mind, and lime salts in the form of phosphates or glycerophosphates are useful. The tendency to anæmia must not be lost sight of, and administration of iron is especially useful in the early months. Exercise is necessary, but should not be violent or attended by risk of accident, which may result in abortion. The more energetic forms of outdoor exercise should therefore be avoided, but walking is useful at all periods. Golf and swimming may be allowed during the first half of pregnancy. Tennis, riding, and dancing are to be forbidden. If for any reason exercise cannot be taken, daily massage of the limbs and back forms a useful substitute for it.

Few, if any, of the ordinary symptoms of pregnancy require treatment. If morning sickness is troublesome the patient should take her first meal before rising, preceded by a mild aperient, such as a seidlitz powder, or a dose of Apenta water.

If nausea continues during the day, alkaline remedies, such as the salts of bismuth, soda, and magnesia, are useful. A simple belt of elastic webbing or the more elaborate ' Pregnancy Belt ' are useful substitutes for corsets. The urine should always be examined at least once a month in the first half, and a regular fortnightly analysis should be made during the second half, of pregnancy, on account of the liability to the appearance of albuminuria at this time. The examination should include reaction, specific gravity, tests for albumen and sugar, and an occasional microscopic examination of deposit. This is of especial importance in a primigravida. Success in treating albuminuria depends entirely upon its early recognition. It will be remembered that in normal conditions the secretion of urine is abundant in pregnancy.

Examination of the gravid uterus during the first three months of pregnancy is usually unnecessary, and should be avoided unless required for purposes of diagnosis. It should then be made with care and gentleness, for a rough internal examination may cause a miscarriage. When the examination is made under anæsthesia there is especial need for caution, as an undue amount of force may then unconsciously be used, in the absence of any check from the sensations of the patient. A complete physical examination should, however, always be made at about the thirtieth week to determine (1) the presentation and position of the fœtus ; (2) the relation between the size of the head and that of the pelvic brim ; (3) the condition of the bony and soft maternal passages ; (4) the presence and rate of the fœtal heart-sounds. The importance of determining these points well in advance of term will be made clear in the section dealing with the management of labour. The examination of presentation and position should be repeated at the thirty-sixth week and again a few days before labour is due.

During the latter half of pregnancy the nipples must be prepared for suckling in the manner described on p. 540.

The systematic supervision of women during pregnancy is known as " antenatal care." The aims and methods of this important preventive aspect of obstetrics will be better appreciated by the student after he has been made familiar with the various complications of pregnancy, labour and the puerperium. For this reason the section on antenatal care has been placed near the end of this book, but the student is advised to read it now.

Part II

ABNORMAL PREGNANCY

Although pregnancy is not a disease, but a normal function of the body, there is no doubt that a pregnant woman is exposed to many serious risks which are peculiar to her condition, while certain maladies to which all women are liable are of increased gravity when associated with the pregnant state. In addition, morbid conditions primarily affecting the ovum are met with which destroy it and lead to its premature expulsion. The pathology of pregnancy thus assumes very large proportions, and comes to embrace a great number of morbid conditions which may affect the mother, the embryo, or the fœtus and its appendages. In order to make the subject intelligible and capable of being dealt with briefly, classification is required, but a practical classification is by no means easy to devise. A simple division into the main groups is, however, easily made ; for while some of the conditions included are abnormal developments of pregnancy, *i.e.*, conditions necessarily associated with the pregnant state, in others the association with pregnancy is only accidental. The first group we may call The Disorders of Pregnancy, for pregnancy is the essential factor in their causation. As examples may be mentioned the disease called *eclampsia*, and the *hydatidiform mole* (vesicular degeneration of the chorion) ; none but pregnant women suffer from these diseases and their many consequences, and they are directly due to some disturbance of the normal course of pregnancy. The second group we may call The Disorders associated with Pregnancy ; they may have been in existence before conception occurred and have become aggravated by pregnancy, such as *valvular disease of the heart ;* or they may arise during the course of pregnancy and interrupt it, like the *acute eruptive fevers.* Instead of subdividing the first group into *fœtal* and *maternal* disorders, as is usually done, we shall classify them as follows :

I. Disorders of Pregnancy

Toxæmias.

(1) Albuminuria and eclampsia.
(2) Toxæmic vomiting.
(3) Acute yellow atrophy of liver.

(4) Ptyalism.*
(5) Pruritus.*
(6) Herpes.*
(7) Mental disturbances.*

Abnormal Conditions of the Gravid Uterus.

(1) Displacements.
(2) Malformations.

Pressure-symptoms.

(1) Œdema.
(2) Varicose veins.
(3) Hæmorrhoids.

Abnormal Conditions of the Ovum.

(1) *The Early Ovum.*

(*a*) Moles.
i. Blood mole—Fleshy mole (hæmatoma mole).
ii. Hydatidiform mole (vesicular degeneration of chorion).
(*b*) Decidual endometritis.

(2) *Placenta and Membranes.*

(*a*) Oligo-hydramnios.
(*b*) Poly-hydramnios.
(*c*) Placental diseases.
Œdema.
Fatty degeneration.
Hæmorrhage.
New growths.
Syphilis.
Tubercle.
Infarction.

Abnormal Implantation of the Ovum.

Ectopic gestation.

II. Disorders associated with Pregnancy

(*a*) Acute eruptive fevers.
(*b*) Syphilis.
(*c*) Tuberculosis.
(*d*) Cardiac disease.
(*e*) Renal disease (Bright's Disease).
(*f*) Infection of urinary tract with the *Bacillus coli*.
(*g*) Diabetes.

* Provisionally classed as toxæmias.

(*h*) Graves' disease.
(*i*) Diseases of the nervous system.
Chorea.
(*j*) Pelvic diseases.
Ovarian and uterine tumours.
Gonorrhœa.

Disorders of Pregnancy

Toxæmias of Pregnancy

Pregnant women are liable to suffer from certain serious disorders which are peculiar to the pregnant state, and which, by common consent, have been placed in a single group known as the *toxæmias of pregnancy*. These disorders, four in number, are: (1) Albuminuria of pregnancy; (2) eclampsia; (3) toxæmic hyperemesis; (4) acute yellow atrophy of the liver.* They have been placed in a single group because they possess many clinical and pathological features in common. They are all accompanied by albuminuria and impairment of renal function, and eclampsia is so frequently preceded by the albuminuria of pregnancy that the latter is generally known as "pre-eclamptic toxæmia." As regards their morbid anatomy, in fatal cases the postmortem findings are similar in all, differing only in degree.

Before proceeding to consider individually the disorders in this group, there are certain general considerations applicable to them all which must be referred to. Thus we must first consider what reasons we have for considering them toxæmic in origin, and also what is known, or surmised, as to the nature and source of the toxæmia.

As regards the first point, it must be said at once that direct proof of their toxæmic origin cannot be advanced, for no toxin or group of toxins has been isolated. Nevertheless, a mass of evidence, based upon the analogy of other diseases known to be toxæmic, and upon scientific inference, has gradually been accumulated, which for practical purposes amounts to proof. Postmortem changes naturally form important evidence, and there is a striking similarity between fatal cases of toxæmia of pregnancy and fatal cases of toxæmia due to known chemical and bacterial poisons. These changes consist mainly of two groups: (*a*) Extensive capillary thrombosis, and interstitial hæmorrhage from rupture of capillaries; (*b*) cell necrosis, sometimes scattered, sometimes affecting large masses, *i.e.*, *massive necrosis;* these are widely distributed, and although the liver and kidneys are the organs chiefly affected, to a less extent they may be found in many others. Changes of this nature and distribution are found in eclampsia, toxæmic vomiting,

* Acute yellow atrophy of the liver may occur apart from pregnancy, but in the great majority of cases the two are associated.

and acute yellow atrophy of the liver. They are also found in fatal cases of poisoning from chloroform, phosphorus, trinitrotoluene, salvarsan and certain other chemical poisons, and in severe bacterial intoxications; they may be largely reproduced in animals by injecting foreign albumens, peptone, or ferment solutions into the blood. An interesting analogy has been pointed out by Leith Murray between the pathological changes found in eclampsia and those due to death from snake poisoning. Cobra venom contains five toxic principles, which can be traced by the effects which they produce, viz.: (1) Thrombolytic; (2) hæmolytic; (3) hæmagglutinative; (4) endotheliolytic; (5) neurotoxic. He suggests that similar effects can all be traced in eclampsia: (1) Fibrinous thrombosis is widespread in the liver; (2) destruction of blood cells occurs; (3) non-fibrinous thrombi are found; (4) degeneration of capillary endothelium is common; (5) convulsions or coma may be due to direct action of a toxic body upon the higher nerve centres. This analogy cannot fail to lend support to the toxæmic theory of the causation of eclampsia.

Still further evidence of a toxæmic state is to be found in the clinical features of this group of disorders, viz., elevation of blood-pressure, fever, disturbed metabolism and excretory functions, disturbances of the special senses, vomiting, and the supervention in the final stages of coma, with or without convulsions.

Chemical Changes in the Urine and Blood.—An immense amount of chemical investigation upon the blood and urine, and other body tissues and fluids, has failed to throw light upon the nature of the toxæmia. The more recent work has corrected the view that a high ammonia coefficient and other alterations in the nitrogen partition of the urine were of especial significance. These alterations were formerly held to prove that eclampsia was a primary autointoxication due to a profound disturbance of protein metabolism, especially of hepatic function; but we now know that in minor degrees they are physiological to pregnancy, and that the extreme alterations sometimes found in eclampsia and in hyperemesis are mainly due to the vomiting and starvation incidental to these disorders. These chemical considerations are still of such importance that a short account of them will be given.

In the healthy non-pregnant state, with a daily excretion of 14 to 18 grammes of urinary nitrogen, the nitrogen partition of the urine is as follows:

Urea	86 to 89	per cent.	of the total urinary N.
Ammonia	3 to 5	,,	,, ,,
Creatinin	3	,,	,, ,,
Uric Acid	0·7	,,	,, ,,
Undetermined (amino acid) N.	3 to 8	,,	,, ,,

The amount of urea in the blood ranges from 20 to 30 mgrms. per 100 c.c., and is very rarely below 20. Both the nitrogen partition of the urine and the amount of blood urea are dependent on the quantity of protein ingested, as urea is a product of exogenous (food) metabolism in normal individuals; both undergo considerable alterations during starvation.

In *normal pregnancy* there is alteration in both the quantity and the quality of the nitrogen excretion; a considerable retention of nitrogen occurs in the body, and the nitrogen partition is altered (see p. 70). The percentage of total nitrogen excreted as urea is always below 80 and sometimes falls as low as 70, and the percentage excreted as ammonia and amino acids rises. The blood urea is low, ranging from 15 to 16 mgrms. per 100 c.c., and is very rarely above 20 (de Wesselow). The fibrinogen content of the blood is greatly increased, as revealed by estimation of the fibrinogen nitrogen content of the plasma; in the non-pregnant state this equals 40 mgrms. per 100 c.c., whereas in normal pregnancy it is nearly doubled.

More striking deviations still are found during *normal labour;* the urea nitrogen may fall to 60 or even 50 per cent., the ammonia nitrogen rise to 10 per cent., and the undetermined nitrogen reach the high level of 20 to 30 per cent. of the total nitrogen (de Wesselow). This is easily accounted for by the muscular exertion and semi-starvation which accompany labour; a temporary ketosis occurs, and lactic acid is formed, both of which result in a deviation of ammonia for neutralisation purposes. Such figures illustrate the comparative instability of the nitrogen partition in pregnant women, and the caution with which its significance should be interpreted. It will also be apparent that *no undue strain is placed upon the maternal excretory functions during pregnancy*, for the amount of nitrogenous waste products in the blood is less than normal.

In the *toxæmias of pregnancy* the nitrogen partition of the urine seldom shows alterations which cannot be paralleled in normal pregnancy and labour; but violent fluctuations are occasionally found, and de Wesselow records two cases of eclampsia in which the urea nitrogen fell to 30 per cent. and the ammonia and undetermined nitrogen rose to 20 and 50 per cent. respectively of the total nitrogen. In persistent and severe vomiting, owing to prolonged starvation, extreme alterations in the nitrogen partition are the rule. Until fairly recently such alterations were considered to be proof that these disorders were a primary autointoxication with the products of a perverted protein metabolism. Enough has been said for the student to realise that they are merely *effects* of these disorders, and are due partly to a diminished nitrogen intake and partly to the great production of acetone bodies whereby ammonia is deviated from the normal metabolic path which

leads to urea formation, both of which occur in starvation and vomiting.

Our reasons, therefore, for regarding these disorders as toxæmias still rest solely on the fact that in their clinical aspects and morbid anatomy they are paralleled by other toxæmic states caused by known chemical or bacterial poisons. Chemical investigations have failed to reveal a specific toxin, and have so far done no more than demonstrate effects.

Pathological Anatomy.—*Albuminuria of pregnancy* is rarely fatal unless complicated with eclampsia ; the pathology of the albuminuria of pregnancy has therefore been somewhat difficult to elucidate. In severe cases of the acute type death may occur before the onset of convulsions, and the pathological changes found are the same as in eclampsia. In mild cases it is reasonable to suppose that the renal changes are similar, though less pronounced, but it is uncertain whether necrotic changes occur in the liver.

In fatal cases of *Eclampsia* constant and characteristic morbid changes occur in the liver and kidneys, and a further series of changes is also found in the spleen, brain, and other organs.

Kidneys and Ureters.—Definite renal changes are found in 99 per cent. of autopsies on cases of eclampsia. The most important changes occur in the renal cortex, and they are of the nature of degeneration, not inflammation. The whole kidney is enlarged, the cortex swollen and pale. Cloudy swelling with granular and fatty degeneration of the epithelial cells of the convoluted tubules is apparent on microscopical examination (Fig. 60). Small interstitial hæmorrhages and areas of necrosis are also found in the cortex, and thrombosis is often present in the capillaries of the glomeruli. These changes are not universal, but occur in patches, the remainder of the renal substance being healthy ; they are transient, and, in the great majority of cases that recover, they disappear rapidly after labour, but the condition may occasionally pass into true parenchymatous nephritis. The rapid disappearance of the renal changes can of course be watched by observation of the urine during the puerperium.

Dilatation of the right ureter has been frequently found in autopsies upon cases of eclampsia, and the older writers laid great stress upon it as an indication of pressure leading to derangement of the function of the kidney. It is, however, now known that dilatation of the right ureter is found with such frequency in autopsies upon pregnant women who have died from various causes, that it certainly has no special relation to albuminuria, and may perhaps be regarded as a normal condition towards the end of pregnancy. It may be occasioned by the uterus itself, or by direct pressure of the fœtal head upon

the ureter ; for we know that in the last two to three months of pregnancy the fœtal head usually occupies the pelvic brim.

Liver.—Changes in this organ are invariably found in eclampsia ; they are of great importance and are regarded as lesions specifically characteristic of this disease. To the naked eye hæmorrhages beneath the capsule and on the cut surface are the most constant feature ; they may be small and numerous, or they may, by fusion, form large areas. The whole organ may be enlarged by the extent of these hæmorrhages ; some-

Fig. 60.—Renal Tubules from a Case of Eclampsia ; Numerous Fat Globules occur in the Degenerated Cells. (Hamilton Bell.)

times it is small and resembles the liver of acute yellow atrophy. On the cut surface areas of ill-defined outline may be seen, paler than the surrounding liver substance, which, when examined microscopically, appear as areas of massive necrosis (Plate III.).

Microscopically the changes which are found are as follows :—(*a*) Degeneration of hepatic cells, beginning at the periphery of the hepatic lobule and proceeding, in some areas, to total cell destruction (Plate IV. *a*). In the early stages the affected cells become cloudy and lose their affinity for stains ; later the cell

LIVER FROM A FATAL CASE OF ECLAMPSIA.

The general colour of the liver is pale yellow, except for the red mottling due to hæmorrhages. Note the multiple areas of subcapsular hæmorrhage, and the interstitial hæmorrhages seen on the cut surface. (From a specimen in the Museum of the City of London Maternity Hospital.)

[*To face p.* 100.

body becomes disintegrated and breaks down into *débris*, the nucleus being the last part to persist. (*b*) Interstitial hæmorrhages, either diffused and slight in extent, or forming gross hæmorrhages, with compression or disintegration of the liver substance. Considerable deposits of fibrin are also found. (*c*) Thrombosis of vessels, for the most part those of microscopic size, sometimes affecting large ones. Two kinds of thrombi have been observed, viz., the common fibrinous thrombus and the non-fibrinous or agglutinative thrombus. Their importance from the standpoint of causation will be referred to below. (*d*) Degenerative changes have been found in the endothelial lining of the capillaries, and to these changes the interstitial hæmorrhages are probably due.

The changes just described usually occur diffused over the whole organ in greater or less degree. In addition blocks of tissue of considerable size may be affected, the so-called 'massive necrosis.' This probably arises from blocking of a vessel of considerable size by thrombosis, which suddenly cuts off the blood supply from the area served by it.

Brain.—Morbid appearances may be found consisting of small hæmorrhages and scattered areas of necrosis; in the neighbourhood of the areas of necrosis capillary thrombosis similar to that in the liver is found. Occasionally a large cortical or ventricular hæmorrhage is found.

Heart.—Scattered areas of cloudy degeneration and necrosis also occur in the heart muscle.

Among the rarer changes found in eclampsia may be mentioned necrosis in the pancreas and certain of the endocrinous glands, and embolic infarction of the lungs; the pulmonary infarcts may contain villi and syncytial masses. As illustrating the general tendency to hæmorrhage in eclampsia it may be mentioned that gross hæmorrhages are sometimes found apart from the viscera, *e.g.*, in the connective tissue of the abdomen.

Fœtus.—It is a significant fact that convulsions may occur in the child born of an eclamptic mother; usually, however, it is born dead. In the liver, changes resembling those in the maternal liver have been met with, and some observers state that they can always be found. Renal changes also occur, but it is difficult to distinguish them from similar changes, not uncommonly found, in fœtuses which die from other causes.

The Nature and Source of the Toxæmia.—There are many theories, and in the midst of so much uncertainty and speculation only a brief survey will be given here. It may be incorrect to group these disorders under one heading and to attribute their manifestations to a common causal agency; nevertheless this will always be the tendency until convincing reasons to the contrary are forthcoming. The theories here reviewed will

be: (1) the Placental; (2) the Maternal; (3) the Fœtal; and (4) the Pressure.

(1) *The Placental Theory*, in one form or another, is in all probability the one most likely to be proved correct, and is already supported by a great deal of evidence. The maternal organism, according to this theory, is directly poisoned by toxins elaborated by the chorionic epithelium. There is no need to invoke, for this purpose, the entrance of detached portions of syncytium into the maternal circulation—an occurrence to which great importance was attached by Schmorl, who first demonstrated, in fatal cases of eclampsia, pulmonary emboli containing small chorionic villi and masses of syncytium —for the whole enormous surface presented by the villi and covered by chorionic epithelium is bathed in maternal blood; if, therefore, toxic bodies are formed in the chorionic epithelium, conditions could hardly be more favourable for their absorption into the maternal organism. The placenta is known to possess many powerful ferments. The aseptic autolysis of the shed placenta has received much attention, and Dryfus has demonstrated that the activity of the intracellular ferment of the placenta is greatly increased in eclampsia; he claims also to have demonstrated that autolysis takes place in the eclamptic placenta before it is shed (*i.e.*, during pregnancy), in which case toxic products of protein autolysis would enter the maternal circulation. Such substances, even in small doses, may be sufficiently toxic to the maternal organism to increase the coagulability of the blood and to activate autolytic ferments in organs such as the liver and kidney, leading to cellular, and ultimately to focal necrosis. Once the placental toxins have begun their work, these effects will soon be supplemented by other toxins derived from the perverted action of the viscera or from extensive areas of tissue which have undergone necrosis. When the liver and kidneys are sufficiently damaged to interfere with their functions toxins will accumulate in the blood, and a form of vicious circle is established leading ultimately to the profound toxæmia and widespread pathological changes which characterise eclampsia. Interesting observations bearing upon this point have been made by James Young. This observer claims to have shown that if a placental cotyledon becomes separated from the uterine wall by hæmorrhage, or by some other interference with the maternal blood supply, massive necrosis of the separated cotyledon ensues. In the eclamptic placenta he has constantly found such areas in the form of 'red infarcts.' He suggests that such a mass of necrotic tissue may become the source of toxic autolytic bodies capable of producing eclampsia or other forms of pregnancy toxæmia. A serious objection to the placental theory is that in a considerable proportion of cases eclampsia begins after labour, during

the first few days—first to fourth—of the puerperium (see p. 110) ; in such cases we must assume a continuance or increase of the toxæmia after labour, which is the opposite of what usually occurs. But the difficulty offered by post-partum cases is diminished when we consider the widespread degenerative changes which may occur in the liver, kidneys and other viscera ; such changes may be formidable enough to *maintain* a condition of toxæmia even after the source of the toxic bodies which induced those changes has been eliminated. It is reasonable to suppose that when the placental toxins have done their work their effects will soon be supplemented by other toxins derived from the perverted action of important viscera or from extensive areas of tissue which have undergone necrosis.

The Maternal Theory regards pregnancy toxæmia as an auto-intoxication due to the breakdown of general metabolism ; one of the first results of this autointoxication is that renal changes occur which profoundly affect urinary excretion and thus aggravate the toxæmic condition. The objections to a theory of perverted metabolism have already been mentioned. It has been pointed out that in normal pregnancy there is a physiological alteration in the general metabolism consisting in a retention of nitrogen by the maternal organism and an alteration in the nitrogen partition of the urine. It has been also pointed out that the further alterations in the nitrogen partition which accompany the toxæmias of pregnancy must be regarded as effects and not as the cause of the toxæmia. The maternal theory of a primary metabolic autointoxication therefore breaks down in the light of recent work.

The Fœtal Theory is not well supported by facts. It suggests that the primary cause of the toxæmia is the undue accumulation in the maternal blood of waste products derived from the fœtus. Under normal conditions there is an adjustment, it is imagined, of the maternal excretory functions to enable them to cope with the increased output of waste products necessitated by the development of the fœtus ; this adjustment might conceivably break down, either from excessive maternal absorption of waste products resulting from fœtal disease, or from deficient elimination produced by functional or structural changes in the great maternal organs of excretion. Two strong objections can be at once given to this theory : (1) Toxæmia of the gravest kind may occur in association with vesicular mole, in which there is no fœtus, and, consequently, fœtal metabolism can play no part ; (2) chemical observation of the maternal blood and urine show there is no accumulation of waste products ; in fact, the influence, if any, of the fœtus is actually to diminish the quantities present in the circulation of such metabolic products as require excretion.

Pressure Theories.—The occurrence of dilatation of the ureter in eclampsia has been already referred to. When this association was first observed it was regarded as a possible explanation of the disease, the convulsions being regarded as induced by acute dilatation of the ureter and renal pelvis. This theory is disproved by the fact that ureteral dilatation is so frequently found in normal pregnancy. Paramore maintains that the intra-abdominal pressure is raised in pregnancy, and that an exaggeration of this pressure (as by twin pregnancy, hydramnios, primigravidity, straining due to constipation, vomiting late in pregnancy) may determine a metabolic toxæmia by mechanical interference with the capillary circulation of the liver and kidneys whereby their excretory functions are impaired. The pressure theory, at all events so far as it may explain certain mild cases of albuminuria of pregnancy by pressure on the renal veins, has been lately revived by Cook. Anatomical relationships render the left renal vein more liable to suffer pressure than the right, and Cook has found, by ureterical catheterisation, that the amount of albumen was usually greater from the left kidney than the right. He therefore suggests that mechanical pressure and a resulting hyperæmia of the left kidney may exercise a certain ætiological influence. He also considers it possible that, in association with the implied compression of the left renal vein, a circulatory disturbance of the suprarenal gland may occur, which might explain certain features of eclampsia itself.

While in the meantime no definite conclusion can be reached, it must be said that the weight of evidence is strongly in favour of the placental (chorionic) origin of pregnancy toxæmias. In the case of eclampsia the evidence is stronger than in any of the other toxæmias.

Albuminuria of Pregnancy

Albuminuria occurring during pregnancy may be due to (1) *pre-existing renal disease—e.g.*, chronic nephritis ; (2) *pregnancy.* The latter is spoken of as 'the albuminuria of pregnancy,' or 'pre-eclamptic toxæmia,' and must be sharply distinguished from the former variety, which will be considered in the group of 'Disorders associated with Pregnancy.' Although eclampsia may very exceptionally occur without albuminuria, they are almost invariably associated. This association is indeed so marked that the conclusion cannot be avoided that they are different degrees of the same disorder and are due to one and the same cause. It must, however, always be borne in mind that the majority of cases of albuminuria of pregnancy terminate favourably without the supervention of eclampsia ; further, it cannot be said that the higher the degree of albuminuria the greater is the risk of eclampsia.

Strictly speaking, albuminuria is but a symptom, and in the disease which is conveniently designated 'the albuminuria of pregnancy' other clinical features of great importance are found besides the presence of albumen in the urine. We must be careful, therefore, to exclude, in addition to pre-existing renal disease, such transient causes of albuminuria as fatigue and dyspepsia ('functional albuminuria'), which may give rise to it temporarily in any circumstances. Albumen due to these causes occurs only in traces. But no case of slight and symptomless albuminuria in a pregnant woman is to be regarded as 'functional' until investigation and further observation have excluded the more serious varieties. Contradictory statistics have been published as to the frequency with which albuminuria is to be found in pregnant women, the proportion varying, according to different observers, from 3 to 50 per cent. The highest rate of frequency occurs in parturient women, and there is no doubt that in a large majority of primiparæ, and in a smaller proportion of multiparæ, traces of albumen occur in the urine during normal labour, and disappear at once when labour is over. This condition does not concern us at present, but will be referred to again later on. Excluding parturition, the rate of frequency of albuminuria in pregnant women probably does not exceed 3 to 5 per cent., and from this must still be deducted cases of pre-existing renal disease and cases of transient functional albuminuria. It will therefore be seen that the disease we are considering is fairly uncommon.

Clinical Features.—The albuminuria of pregnancy is practically confined to the last half of pregnancy and seldom appears before the seventh lunar month, although cases of eclampsia at the fifth month have been recorded. It is much more frequent in primigravidæ than in multiparæ, and in twin than in single pregnancies. Cases vary greatly in severity. In some the only symptoms are a small amount of albumen in the urine and slight œdema of the lower extremities, both of which disappear under treatment or may even persist unaccompanied by other symptoms and without altering the course of pregnancy. In others the course of the disease is much more unfavourable; symptoms may progressively become more serious or may be severe from the very first. Every case, however mild, requires careful management, for the risk of other and more serious symptoms supervening is always great. Two clinical types may be recognised, though many cases do not conform strictly to either type, but present features of both.

In the *subacute* type the onset is gradual and the course is slow. In the earlier stages the urine is abundant and the amount of albumen is slight, sometimes only a trace, but tending progressively to increase. The amount of albumen is a rough indication of the severity of the case, but is not in itself

a reliable index of the liability to eclampsia, for many cases with a heavy albumen output terminate without convulsions. Hyaline and granular casts can always be found. Œdema appears early and is usually the first thing to attract attention ; it is first noticed in the feet and legs, next being most noticeable in the vulva and abdominal wall, and ultimately becoming generalised. The œdema of the legs may be extreme, and sometimes the labia majora become greatly enlarged so as to interfere with the dilatation of the vulva during labour. Clinical experience shows that patients with extreme œdema rarely get eclampsia. Anæmia is usually pronounced, and the pallor of the face and mucous membranes is a striking feature of these cases, often arousing at once the suspicion of albuminuria. The blood pressure is seldom raised in the mild cases, but in the severe may rise to 170 or 180. A high blood-pressure is probably the most useful clinical criterion we possess for estimating the severity of a case. In the absence of treatment the symptoms become progressively worse ; the amount of urine diminishes and contains increasing amounts of albumen, the blood-pressure gradually rises and toxæmic symptoms appear, such as headache, vomiting, drowsiness, dimness of vision ; ultimately eclampsia may supervene. In the subacute type of the albuminuria of pregnancy the tendency to eclampsia is not great.

In the *acute* type, which is less common but much more serious, the onset is more sudden and the course more rapid ; in the worst cases coma or convulsions may supervene within a few days. From the first the amount of urine is diminished and the degree of albuminuria is high. Œdema is usually slight. Headache, vomiting, dimness of vision and other toxæmic symptoms appear early. The blood-pressure is always raised and may reach 180 or 200. When these severe symptoms occur the patient is said to be in the ' pre-eclamptic state.' In the acute type of albuminuria the tendency to eclampsia is great.

Death of the Fœtus and Premature Labour.—A heavy fœtal mortality, largely independent of eclampsia, attends untreated cases of albuminuria of pregnancy. Death of the fœtus is much more likely to occur with the acute than with the subacute type of the disease ; in the former the fœtal mortality probably amounts to 50 per cent. The fœtus perishes *in utero* and is usually retained for some days before being born in a macerated state. Often a living premature child is born, but it is usually undersized and feeble, and its chances of survival are small. Premature labour is nature's method of effecting a cure ; amelioration of the general symptoms sometimes follows death of the fœtus, even when it is retained for some time in the uterus. Placental disease, such as extensive infarction or retroplacental hæmorrhage, is present in a considerable pro-

portion of these cases, and appears to be an important factor in causing the death of the fœtus and in inducing labour prematurely,

The Nature of the Renal Lesion and its Effects on the Renal Function.—From a functional standpoint, the lesion does not differ in any way from the mixed type of nephritis so frequently seen in non-pregnant individuals. The presence of œdema points to defective elimination of chlorides, and the renal lesion in this respect presents the characteristics of the hydræmic or parenchymatous type of nephritis. Tests for renal function reveal also a defective excretory power for nitrogenous waste products, and in this respect the lesion presents the characteristic of the azotæmic or interstitial type of nephritis. The functional defect of the kidney is not, therefore, one that is peculiar to pregnancy.

Even the most severe cases, however, differ from chronic nephritis in that the blood urea is not much increased. In the pregnant woman the conditions present militate against large accumulations of urea in the blood (see p. 98), even when the renal defect is of considerable severity, and the blood urea test is therefore a comparatively poor criterion for estimating the progress and severity of the renal lesion. According to de Wesselow, the renal defect is best detected and measured by submitting the urea-excretion function to a strain, as in the *urea concentration test.* This test shows that defect in the urea-excretory power of the kidney appears to be the rule in the toxæmias of pregnancy.

The Maternal Prognosis.—We do not know the exact proportion of cases which terminate in eclampsia ; it is probably small. It has already been stated that the tendency to eclampsia is slight in the subacute cases but great in the acute, and that a combination of severe symptoms known as the ' pre-eclamptic state ' points to the onset of eclampsia. In the very severe cases the patient, before she gets convulsions, may die comatose, especially if there is jaundice or suppression of urine. Few conditions are more amenable to treatment than the albuminuria of pregnancy, and the prognosis depends essentially on the response to treatment ; if improvement under treatment is not satisfactory, risks can be avoided and a good prognosis maintained by the induction of labour. As regards the *remote prognosis,* permanent renal damage is unusual, but is more liable to follow the subacute than the acute type. The longer the kidney is passing albumen, the greater is the risk of permanent damage, which is a good reason for not persisting with medical treatment too long should the albumen not disappear.

The Diagnosis of Albuminuria of Pregnancy from Chronic Nephritis.—This is discussed on p. 176.

Treatment of the Albuminuria of Pregnancy.—The early recognition of the occurrence of albuminuria in pregnancy is of great importance both to the mother and the fœtus. Frequent examinations of the urine (see p. 93) during pregnancy, whether apparently healthy or not, are indispensable in order to obtain the earliest indication of renal trouble, and the importance of making these examinations in all normal cases has been already pointed out. The presence of albumen is a warning sign that a *state of toxæmia may be present.* Further investigation must then be made in order to decide whether the condition is a toxic albuminuria or not. The importance of treating albuminuria early lies in the fact that such treatment is almost always successful in averting eclampsia, and must be insisted upon in all cases, whether the patient is obviously ill or not. During the course of the treatment daily estimations of the total urinary secretion ought also to be made, for a rapid fall in the urinary secretion is an important premonitory sign of eclampsia.

The treatment consists in the main in promoting free action of the various organs of excretion, and regulating diet so as to diminish as far as possible the work thrown upon the digestive and secretory organs, especially the liver and kidneys. Milk should be the staple article of diet, and the patient should take from 3 to 4 pints daily, but except in the worst cases fish and chicken may be added. The diet should be free from salt. Alcohol, meat, and rich food must, of course, be forbidden, and the skin should be kept acting freely by daily sponging. In a severe case the patient should be confined to bed, and the eliminative treatment described on p. 118 carried out either partially, or, if necessary, in its entirety. The effect of treatment can easily be watched by systematic examination of the urine, and in a favourable case the amount of albumen will diminish and the casts disappear, while the amount of urea remains satisfactory ; but it will be remembered that upon milk diet the excretion of urea is naturally below normal. The anasarca will usually diminish greatly if the patient is kept in bed. Sometimes a large labial swelling due to œdema is formed, which causes considerable distress ; this may be relieved by puncture with a Southey's tube under careful aseptic precautions. If the course of the disease canot be controlled in this way the prognosis is grave ; the fœtus will probably die *in utero ;* or premature labour may come on, with the sacrifice of the life of the child ; or possibly the dreaded complication of eclampsia may supervene.

In all serious cases an ophthalmoscopic examination of the fundus should be made. If retinal hæmorrhage or exudates are found the condition is too grave for palliative treatment, and pregnancy must be terminated. A high percentage of albumen,

persisting in spite of treatment, is of almost equally grave significance.

The induction of premature labour in cases which resist medical treatment should not be delayed. It offers an escape from the risks of eclampsia and of permanent damage to the kidneys, and, the chances of the fœtus being already seriously jeopardised, the question can be weighed almost solely with reference to the interests of the mother.

Renal efficiency tests have a certain value in assisting the clinician to decide whether, in the interests of the mother, the pregnancy should be terminated or allowed to continue. According to de Wesselow, when the blood urea is above 40 mgrm. per 100 c.c., and the urea concentration test is below 2 per cent., the termination of pregnancy is indicated. Such figures would signify very severe renal damage, and the indications for terminating pregnancy would probably be sufficiently indicated by the clinical state of the patient. Routine clinical experience is probably, in the present state of our knowledge, the more reliable guide.

Eclampsia

Occurrence.—Although eclampsia is one of the most formidable of the risks of child-bearing it is fortunately of comparatively rare occurrence. From the Registrar-General's reports for England and Wales, for Scotland and for Ireland, it would appear that 600 women lose their lives every year from eclampsia ; if the average death rate is calculated as being 22 per cent. (see below), it follows that nearly 3,000 cases of eclampsia occur in this country every year. The liability to eclampsia is very much greater during the first than any subsequent pregnancy, about 70 per cent. of cases occurring in primigravidæ. The liability of twin pregnancy to eclampsia is four or five times greater than single pregnancy. About 90 per cent. of cases occur after the sixth month (twenty-fourth week), and about 55 per cent. between the thirty-sixth week and full term ; but eclampsia has been observed as early as sixteen to eighteen weeks, and a number of instances has been recorded in which it has occurred with a vesicular mole, no fœtus being present at all. In 80 per cent. of cases eclampsia is preceded by premonitory symptoms of the albuminuria of pregnancy ; in the remainder, called *fulminant* cases, the disease occurs without warning in women who up to the time of its onset were in apparently good health, though it is highly probable that, had the urine been examined, albumen would in the majority of cases have been found shortly before the onset of convulsions. In four out of every five cases, therefore, an opportunity of prophylactic treatment would present itself. When the albuminuria of pregnancy is appropriately treated it scarcely ever

terminates in eclampsia. Cases have been recorded in which no albumen was found in the urine, but this is a very great rarity. In 64 per cent. of cases the convulsions begin before, or almost simultaneously with, the onset of labour (*ante-partum* eclampsia); in 19 per cent. during labour (*intra-partum* eclampsia); and in 17 per cent. after labour is over (*post-partum* eclampsia.* In post-partum cases the onset of the convulsions is very rarely delayed for more than forty-eight hours after labour. It is unusual for eclampsia to recur in subsequent pregnancies, and one attack would seem to confer a relative immunity for the future; if convulsions occur in a woman who gives a history of eclampsia in a previous pregnancy, chronic nephritis and uræmic convulsions should be suspected.

Clinical Features.—Although eclampsia may attack a pregnant woman who has apparently been in good health up to the moment of its onset, a series of well-marked symptoms often precedes its occurrence. The symptoms associated with the albuminuria of pregnancy may have been present for some time; but in addition certain other symptoms often occur which constitute what is called the *pre-eclamptic state*. They are (1) severe headache, usually frontal, but sometimes occipital; (2) functional disturbances of vision, such as muscæ volitantes, diplopia, hemianopsia, and temporary amblyopia; (3) occasionally well-marked albuminuric retinitis, with considerable failure of vision; (4) puffiness of the eyelids and cheeks; (5) severe epigastric pain, with giddiness, nausea, or vomiting; (6) occasionally, attacks of *petit mal*. The condition of the urine may furnish premonitory signs, and a sudden diminution in the total amount of the urinary secretion may occur, and must be regarded as of great significance. In addition, the amount of albumen may rise, the amount of urea may fall, and the proportion of ammonia nitrogen consequently become increased (see p. 98). Clinical observations indicate that a considerable rise in blood-pressure usually precedes the occurrence of fits; during the stage of convulsions blood-pressure is invariably raised.

The convulsions are epileptiform in character, and consist of a stage of tonic, followed by a stage of clonic, contractions. Each convulsion is ushered in by fibrillary twitchings in the muscles of the face, tongue, and limbs, often followed by conjugate deviation of the head and eyes—usually to the left

* A Report on the results of a collective investigation into upwards of 2,000 cases of eclampsia, taken from the case records of certain hospitals in Great Britain and Ireland, and covering the ten years 1911 to 1920, was presented to the British Congress of Obstetrics and Gynæcology in 1922. All statistical and other figures quoted here are taken from this Report. See *Journal of Obstetrics and Gynæcology of the British Empire*, 1922, vol. 29.

side. Then comes a brief period of tonic contraction in which respiration ceases, and the trunk may pass into the condition of opisthotonos ; this is accompanied by marked cyanosis, the face being livid, and the tongue protruded between the teeth. This stage usually lasts less than half a minute, and gives place to general clonic contractions which appear to affect all the voluntary muscles of the body. Slight respiratory movements now occur, and the cyanosis gradually passes off during the period of three to five minutes which this stage generally occupies. A varying amount of mental disturbance follows the fit : in some cases the patient appears to be merely sleepy or somewhat dazed for a few minutes ; in some cases there is a brief period of coma ; in others deep coma persists, the patient failing to regain consciousness before the onset of the next convulsion.

The convulsions are almost always multiple ; they may occur every hour, or every half-hour ; in more serious cases, with greater frequency than this. As many as a hundred fits may occur in a single case. During the eclamptic state the excretion of urine is greatly diminished, and may for some hours be suppressed ; it frequently contains blood, and nearly always a large amount of albumen, becoming solid on boiling. In all cases of eclampsia the urine must be examined, the catheter being employed to obtain a specimen if necessary. A high blood-pressure is always present in fully-developed eclampsia, and readings of over 200 mm. are often met with. When a considerable number of fits has occurred, the temperature usually rises to 101° to 102° F., and in some cases there is hyperpyrexia. Death may result from coma, from cerebral hæmorrhage, or from pulmonary œdema.

Diagnosis.—It is necessary to distinguish the following conditions from eclampsia : (1) epilepsy ; (2) hysteria and hystero-epilepsy ; (3) convulsions or coma due to cerebral disease, diabetes, or acute poisoning. *Uræmic convulsions* are difficult to distinguish from eclampsia, but the general line of treatment to be pursued is much the same in both. *Epilepsy* can usually be recognised by the history obtained from the patient or her friends ; when a history cannot be obtained, the condition of the urine furnishes the most reliable means of distinction ; but it must be recollected that in the rare cases of eclampsia without albuminuria the absence of albumen from the urine will be misleading. In general clinical features, the *status epilepticus* closely resembles a severe case of eclamptic coma with elevation of temperature. *Hysterical* fits, and *coma* due to causes other than renal, must be differentiated by attention to the special features of these disorders, into which we cannot enter here.

Prognosis.—The outlook in eclampsia is always very serious both for mother and fœtus. The maternal mortality varies

considerably with the severity of the cases and the method of treatment employed.

In the recent British collective investigation, analysed and reported by Eden, the total maternal mortality, irrespective of the severity of the cases or of the methods of treatment, amounted to 22 per cent. With the cases graded into 'severe' and 'mild,' a very considerable difference in the mortality rates was apparent. As *severe cases* were considered those in which any two of the following six symptoms occurred: deep coma, a number of fits greater than ten, a pulse rate over 120, a temperature above 103° F., a blood-pressure of over 200 mm., and a urine which became solid on boiling. Rather less than one-half of the cases were of the severe type. The mortality of the severe cases amounted to 32 per cent., and of the mild cases to 7 per cent.

The greater the number of fits the more serious is the prognosis; when more than twenty fits occur it is said that the mortality is upwards of 50 per cent. The persistence of fits after delivery is not of unfavourable import, for the mortality of such cases is found to be no higher than the average. Anuria which does not yield to treatment is always of the gravest significance. Jaundice is rare, and usually indicates a fatal termination.

As regards the method of treatment also, the mortality shows considerable variations. Professor Stroganoff, the Russian obstetrician, was in 1911 able to report 600 cases treated by his ultra-conservative method (see later) with a mortality of only 8 per cent. The mortality at the Rotunda Hospital, Dublin, where eclampsia is also treated conservatively, is only 10 per cent. Both these examples compare favourably with the general mortality of upwards of 22 per cent. In considering these figures it should be taken into account that there is evidence that eclampsia may be a milder disease in one country than in another, and that the severity may also vary in different parts of the same country. It is possible also that ante-natal care may better succeed in preventing the slight cases than the severe or fulminant cases, and therefore the disease would, in consequence, be attended by a relatively higher mortality.

The Cause of Death in Eclampsia.—Death may be due to the intensity of the toxæmia (as evidenced *post-mortem* by profound degenerative changes in the liver and other organs), to exhaustion and heart failure (as a direct consequence of many rapidly recurring fits), to pulmonary œdema and septic pneumonia (due to the continuation of fits and coma and the aspiration of saliva, mucus, or vomit), to cerebral hæmorrhage (not uncommon, and due to the combined effect of high blood-pressure and degenerative changes in the walls of the blood vessels) or to pulmonary embolism. After the acute atttack is over, puer-

peral sepsis is a not uncommon cause of death, for eclamptic patients are very prone to septic infection. The injuries and accidents due to operative delivery account for a certain number of deaths, for a profoundly toxæmic and exhausted patient is not in a good state to stand shock and loss of blood.

The Remote Maternal Prognosis.—It is very rare for eclampsia to recur in subsequent pregnancies. A striking capacity for rapid improvement is shown by the kidney; as a rule the blood-pressure falls to normal in a few days and the albumen disappears from the urine in two or three weeks. It is unusual for chronic renal disease to result from eclampsia, but if albuminuria persists for as long as six weeks after recovery from the fits, in spite of treatment, permanent damage to the kidney should be suspected. In severe cases which recover, prolonged mental disturbance may continue, or insanity may supervene in the puerperium.

The *fœtal mortality* is largely influenced by the period of gestation; in cases at the twenty-eighth week or earlier, it amounts to nearly 100 per cent., becoming less as term is approached. Under the most favourable conditions it is as high as 40 to 50 per cent. The occurrence of convulsions in the new-born child, and of hepatic lesions similar to those of the mother, has been already mentioned. This heavy mortality is to be attributed to prematurity, to toxæmia, to relative placental insufficiency due to retroplacental hæmorrhages, to the injuries and accidents of operative delivery, such as cerebral hæmorrhage or prolapsed cord, or to asphyxiation from the repeated convulsions of the mother with prolonged cyanosis.

Treatment.—Severe cases tax the resources of treatment to an extent unequalled in obstetric complications. Only in the earliest stages can the disease be controlled with any certainty. It is, therefore, most important that the significance of the symptoms of the *pre-eclamptic stage* should be clearly understood, for at this moment *prompt treatment* may avert the convulsions. When once the convulsions have begun, the patient should be sent immediately to the hospital if there is one within reach, or in cases of the better class arrangements should be made for continuous medical and nursing supervision of the best and most experienced kind which may be available. Even if only a single convulsion has occurred, there are possibilities of the gravest developments, and no precautions must be neglected. A specimen of urine should be obtained immediately, and complete examination made, including estimation of the amount of albumen, and a microscopic examination of the centrifugalised deposit.

General Principles.—Cases of eclampsia vary so greatly in severity that no rigid routine can be followed in treating them. The general principles upon which treatment should be based are accordingly of uncommon importance, and must be care-

fully considered. These principles are based upon the view that eclampsia is a complex toxæmia, the original source of which is the placenta; further, secondary sources of toxæmia arise during the course of the disease from profound alterations in metabolism (liver, endocrinous glands), and from failure of the excretory functions of the kidneys. It is not possible by cutting off the original source of the toxæmia, *i.e.*, by emptying the uterus, to cure the disease in every case; a lethal dose of toxins may be already present in the body; or, again, the structural damage sustained by important viscera, such as the liver, may be so great that these organs may fail to recover their functional activity, so that the existing toxæmia is intensified and death ensues. Nevertheless, the disease cannot be finally cured until pregnancy has been ended.

There are accordingly two immediate objects of treatment: (*a*) to terminate the pregnancy; (*b*) to promote the elimination of the toxins, and to neutralise their effects. The relative importance attached by different schools to these two objects of treatment is not the same. One school regards the first as all-important, and is, therefore, prepared to subordinate everything to a rapid emptying of the uterus. To this school the treatment of eclampsia is mainly a *surgical* problem. Another equally important school regards the second object as all-important; the termination of labour is a secondary matter, eliminative treatment is of prime importance, and, accordingly, to these the treatment of eclampsia is mainly a *medical* problem.

(1) *The Surgical School*, assuming that the placenta causes the disease by producing toxins and pouring them into the maternal circulation, argue that the sooner the placenta is got rid of the better; accordingly, in addition to employing eliminative and other medical treatment, they perform Cæsarean section in ante-partum cases, and hasten delivery in intra-partum cases by manual dilatation of the cervix, by using hydrostatic bags, or by version and extraction of the fœtus. The great practical difficulty encountered by the surgical school is that toxæmic patients are extremely sensitive to surgical shock; to the mortality of the disease must therefore be added the mortality of an operation performed under unfavourable circumstances. This objection is met with the plea that if an early resort to operation could always be made, *i.e.*, before the toxæmia has become profound, these difficulties would be largely avoided. A strong reason advanced in favour of rapid emptying of the uterus is that delivery may be expected to bring about cessation of the fits in three cases out of four. But this is not a cogent reason for aiming at rapid delivery, for persistence of fits after delivery does not appear to be of unfavourable import in eclampsia; the mortality is no lower when fits cease after delivery than when they persist.

(2) *The Conservative School* believe that the important things to treat are the patient and the toxæmia; even though the placenta may be the primary cause, they cannot believe that a fully-established disease, already accompanied by profound degenerative changes in important organs, can be favourably influenced by a severe operation in a patient who is already struggling for life and not in a fit state to withstand surgical shock. They aim at controlling the fits and eliminating the toxins by morphia and chloral hydrate, by starvation, purgation, repeated stomach and colon wash-outs, saline infusion and venesection; labour in ante-partum cases may be induced, and when the cervix is fully dilated delivery may be ended by the forceps, but nothing more radical is done to hasten delivery. The most rigid advocates of the medical school do not even practise the induction of labour until the fits have ceased and the patient's condition shows definite improvement. The theoretical difficulty encountered by the medical school is that medical treatment is at the best only palliative, and unless the uterus is emptied the specific source of the toxins will not be cut off.

Comparison of the Results obtained by Medical and Surgical Treatment.—We may now proceed to examine the relative value of these two methods of delivery as they affect the maternal mortality, and for this purpose a large amount of statistical information has lately become available. A few years ago it was hoped that the mortality would be revolutionised by the routine employment of Cæsarean section, the earlier the operation being done the better; modern statistics have dispelled these hopes, and there can now be little doubt that the radical surgical treatment compares most unfavourably with the conservative medical. It has been shown by Peterson that the mortality in America for eclampsia treated by Cæsarean section was 26 per cent., and by Holland that the mortality in Great Britain was 32 per cent.; but it is not strictly fair to use these figures, because no doubt this high mortality was partly accounted for by the fact that many of the operations were performed on severe cases which had failed to respond to medical treatment. Much more reliable are the results obtained by the recent collective investigation in Great Britain, in which the cases were graded into mild and severe; the influence of the method of delivery on the mother's chances of survival is shown by the following table, taken from Eden's analysis:

	Mild.	*Severe.*
(*a*) Natural delivery, assisted delivery or induction of labour	5 per cent.	34 per cent.
(*b*) Cæsarean section	11 ,,	46 ,,
(*c*) *Accouchement forcé*	18 ,,	63 ,,

The average mortality for all mild and for all severe cases has been given on p. 112 as 7 per cent. and 37 per cent. respectively. The figures in this table thus demonstrate (1) that patients delivered naturally, or assisted according to the ordinary obstetrical rules, show both for the mild and severe cases a mortality less than the average; (2) that patients delivered by Cæsarean section, both in the mild and the severe cases, show a mortality much greater than the average; (3) that patients delivered by *accouchement forcé* show a mortality rate so high as to place such a method of delivery entirely beyond the pale. These results constitute a very powerful plea for restraint in the obstetric management of cases of eclampsia and demonstrate that active interference, as represented by Cæsarean section and forcible dilatation of the cervix, diminishes the chances of recovery instead of increasing them.

Passing now to the consideration of conservative medical treatment, it will be seen that the mortality rate is very much lower. The great exponent of medical treatment is Stroganoff, and in this country the Dublin School has for many years treated eclampsia on a uniform conservative plan. In 1911 Stroganoff was able to report 600 cases treated by this method, with a mortality of only 8 per cent., and the mortality of 204 cases treated in Dublin between the years 1903 and 1922 was only 10 per cent. Hastings Tweedy, during his term of mastership at the Rotunda Hospital, treated 83 cases, with a mortality slightly over 7 per cent. It is not surprising, therefore, that after many years of uncertainty, obstetricians throughout the world have come to the conclusion that simple medical treatment, carefully regulated and closely watched, gives the best results and that Cæsarean section should be reserved for very exceptional cases only.

We may now consider the treatment of a case of eclampsia by the conservative method. The Dublin treatment, as standardised by Hastings Tweedy and his followers, has given incomparably the best results in this country and will be described in detail.

The objects which this treatment aims at may be said to be the following: (1) To eliminate the presumable toxins by all possible channels. The means employed are starvation, purgation, gastric and colonic lavage, and saline infusions. (2) To diminish the frequency and number of the fits. The means employed are the limited administration of morphia and chloral, and the avoidance of unnecessary disturbance and stimuli. More reliance is placed on elimination than on sedative drugs for controlling the fits. (3) To prevent, and treat when they arise, cardiac failure, asphyxia and respiratory obstruction. The means employed are constant supervision, posture, oxygen, cardiac stimulants, artificial respiration and clearance of the air

passages, all of which demand skilled medical and nursing supervision. (4) To assist delivery when it can be assisted with the minimum of disturbance to the patient, viz., when the cervix is fully dilated.

General Medical and Nursing Treatment.—The patient is undressed and put to bed between blankets in a separate, very quiet room. She is placed in a good light, so that changes in her colour and aspect can be quickly seen; but whenever her condition allows, the room is kept in semi-darkness. She must never be spoken to, touched, moved, examined or in any way disturbed, except for the necessary purposes of treatment; for any irritating stimulus—auditory, sensory or visual—may provoke a convulsion. She must be under constant observation; the medical man, during the severe stage of the disease at all events, should not leave her, and a skilled nurse must always be beside her. She is kept lying on her side to allow the salivary secretions, always produced in excess during the fits, to escape from the mouth, and to prevent their finding their way into the air-passages while she is unconscious and her reflexes are suspended. As soon as the premonitory signs of a fit are noticed a gag is placed between the teeth to save the tongue from being bitten; as soon as the clonic stage of the fit is over the gag is removed, for it is impossible to swallow with the teeth separated. Nothing should be given by the mouth until the patient is conscious enough to drink from a cup; during unconsciousness swallowing is in abeyance, and the fluid is just as likely to go down the trachea as the œsophagus. Observation is kept on the amount of urine being secreted, and a catheter is passed every eight hours if the patient is comatose, or if no urine is passed naturally. If there is cyanosis oxygen is administered. A good airway is maintained, just as in an anæsthetised patient; a poor air entry and prolonged cyanosis gradually and surely bring cardiac failure. If there are signs of respiratory obstruction the head is turned downwards and the mucus and other secretion allowed to run from the mouth and nose, and all the usual arts of the anæsthetist are employed, *i.e.*, head to side, jaw held forwards, swabbing out of pharynx, gag and tongue forceps. If the patient stops breathing at any time artificial respiration is employed. If the heart shows signs of failing, cardiac stimulants such as camphor or digitalin are injected; venesection, in a congested and cyanotic patient, will often relieve the heart. Success in the treatment of eclampsia depends on unremitting care and on attention to detail.

Morphia and other Sedatives.—As soon as the patient comes under treatment morphia, gr. $\frac{1}{4}$, is injected. If further convulsions occur, or if the patient is very restless, the same dose is repeated. Atropin, gr. $\frac{1}{100}$, may be given with the first dose. After the preliminary injection of morphia, chloral hydrate,

grs. xxx, by the rectum, repeated if necessary, is usually sufficient, and further doses of morphia are seldom advisable. But when the convulsions continue, more morphia may be given, but one grain in the twenty-four hours is the limit; marked slowing of the respiration is the best sign of intolerance. During the last two years the routine use of morphia has been discontinued at the Rotunda Hospital by Fitzgibbon, and he gives it only when the patient is very restless and difficult to control; he is convinced that morphia does not control the fits, that it delays the recovery of the eliminating organs, and that it produces respiratory failure. In rare cases of extreme restlessness and refractoriness, a general anæsthetic may be necessary to enable treatment to be carried out, and chloroform is preferable to ether.

Eliminative Measures.—(a) *Starvation.*—If the patient is conscious she is encouraged to drink large quantities of water, but is allowed nothing else until she has fully recovered. (b) *Purgation.*—It is of the utmost importance to obtain very free action of the bowels; from four to six actions should occur in the twenty-four hours. The best purgatives are castor oil (two ounces), magnesium sulphate (half an ounce), and Mist. Sennæ Co. (three ounces). (c) *Gastric Lavage.*—This is always done except with patients who are sufficiently conscious to drink large quantities of water, and who have not had a meal for six hours. If the patient is restless and intractable time is given for the morphia to act, and then the stomach-tube is passed. The stomach is washed out with successive pints of warm water, or of sodium bicarbonate solution (one drachm to the pint), until the return flow is clear. Before the tube is withdrawn, castor oil or some other purgative, followed by a half-pint of fluid to wash it completely through the tube, is run into the stomach. (d) *Colon Lavage.*—The patient is turned on her left side and the lubricated tube is passed through the anus and as high up as possible without kinking; the tube passes more easily with the fluid running. The bowel is washed out with water or sodium bicarbonate solution in the same way as the stomach. The lavage takes half an hour or more, and gallons of fluid may have to be used before the return flow is clear; the bowels may act copiously, which is all to the good. Colon lavage may be repeated in five or six hours and will invariably bring away large amounts of fæcal matter, the result of the purgatives already given. The bowels are then likely to continue spontaneous action. If fits or coma are persistent, colon lavage may have to be repeated three or four times if spontaneous action of the bowels is not maintained.

Saline Infusion.—The infusion of saline solution must be employed with discrimination; if the kidneys are not acting or if there is much œdema it will do harm by causing pulmonary œdema. In severe cases, if the kidneys and skin are acting

well, saline infusion has a favourable action. Its supposed immediate effect is to lower the concentration of the toxins and to reduce their activity; it certainly produces diuresis and diaphoresis, and thus has a direct eliminative action. The submammary region is the best site for infusion, and one pint at low pressure is slowly run under each breast. Instead of normal saline solution, sodium bicarbonate (strength, one drachm to the pint) may be used; but the introduction of too much sodium bicarbonate solution, especially if given intravenously, is dangerous and may produce the condition of *alkalosis*, characterised by the appearance of tetany. If the patient is still unconscious at the end of eight hours, the submammary infusion may be repeated.

Poultices to the Loins.—The application every two hours of hot linseed-meal poultices to the loins relieves the congestion of the kidneys and increases the secretion of urine; they should always be used when the urine is suppressed or scanty. They should not be too hot, as the skin of an eclamptic patient is very susceptible to burning.

Venesection is not a treatment of eclampsia, but of certain complications which may arise during the course of eclampsia, such as a persistent high blood-pressure of 180 mm. or more, deep cyanosis and a failing heart. Venesection was at one time a routine treatment for eclampsia, based on the idea that a certain amount of toxic material was thereby removed from the circulation; but it is more than doubtful if the withdrawal of blood has any effect in diminishing the toxæmia. Venesection acts chiefly in relieving the right side of an embarrassed heart; the lowering of blood-pressure that follows it is only temporary. The maximum amount of blood that may be withdrawn is 15 ounces.

The Stroganoff Treatment.—This treatment is based on the administration of morphia and chloral hydrate; it differs from the Dublin treatment in the absence of active eliminative measures. The following are the main points of the treatment:

(*a*) Isolation of the patient in a quiet dark room.

(*b*) Attention to the respiratory and cardiac functions: (i.) to cleanse the mouth, throat and nose after the fits, the patient lying on her side; (ii.) fresh air, and if marked cyanosis, oxygen; (iii.) cardiac stimulants, when indicated.

(*c*) Morphia subcutaneously, and chloral by the mouth or rectum, at stated intervals, until the fits are controlled, as follows:—

When first seen	Morphia, gr. ¼.
After 1 hour	Chloral hydrate, gr. 30.
After 3 hours	Morphia, gr. ¼.
After 7 hours	Chloral hydrate, gr. 30.
After 13 hours	Chloral hydrate, gr. 22.
After 21 hours	Chloral hydrate, gr. 22.

(*d*) Chloroform to control the fits, if they are persistent.

(*e*) Venesection and the withdrawal of 15 ounces of blood if the fits or coma persist.

(*f*) One ounce of milk a day.

(*g*) Rupture of the bag of waters if the patient is in labour, and termination of the second stage by forceps.

Stroganoff's own results have been remarkable, and in 1911 he was able to report a series of 600 cases with a mortality of only 8 per cent.

Veratrone.—A drug which has lately come into use for the treatment of eclampsia is *veratrone*, a preparation made from veratrum viride. As a means of arresting fits, or even of relieving coma, veratrone is sometimes remarkably successful. Stevens found that the fits ceased after the injection of veratrone in 55 per cent. of cases of ante-partum eclampsia. The chief action of the drug is to lower the blood-pressure and reduce the pulse-rate. It is not without danger, and it is essential that its employment should be controlled by frequent observation of the blood-pressure and pulse-rate, on account of the danger attending its use when these are not considerably raised. It is chiefly of value for a patient who has a number of fits, and with a blood-pressure of 160 or over and a rapid pulse ; if the blood-pressure is below 140 it is not only valueless but dangerous. According to Bourne, the average relation which the dosage should have to the blood-pressure is as follows : above 195 mm., 1 c.c. ; between 195 and 175 mm., $\frac{3}{4}$ c.c. ; between 175 and 155 mm., $\frac{1}{2}$ c.c. ; between 155 and 140 mm., $\frac{1}{4}$ c.c.

The Management of Labour in Eclampsia. — It has already been sufficiently emphasised that non-interference is the essential feaure of conservative treatment, with the single exception that the second stage should be terminated as soon as the cervix is fully dilated. When labour has begun, its progress is rapid and easy because uterine action is powerful and the fœtus is usually premature.

It is still a matter of controversy whether or no labour should be induced in ante-partum cases. We believe it should. The patient cannot be considered free from danger until the uterus is empty, and the sooner this occurs the better, so long as the method employed to bring it about does no harm ; the process of labour itself does not add to the dangers of eclampsia. The onset of labour is usually easily excited in eclampsia, and the introduction of bougies, or of a small rubber bag after rupture of the membranes, are the gentle methods to employ.

Hyperemesis Gravidarum : Toxæmic Vomiting

The common occurrence of nausea and vomiting as a symptom of normal pregnancy, present usually from the second to the fourth or fifth month, has been mentioned on a previous page

(p. 74). As a symptom it varies greatly in severity, but does not affect the patient's health and has no unfavourable influence upon the ovum. Excessive vomiting (hyperemesis gravidarum) is met with at the same period of gestation, and all gradations between ordinary morning sickness and the worst forms may be met with. Three groups of cases, the causation of which is essentially different, may be distinguished, viz., *associated* vomiting, *neurotic* vomiting, and *toxæmic* vomiting.

Associated Vomiting.—Such conditions as gastric ulcer, gastric cancer, alcoholic gastritis, cirrhosis of the liver, and cerebral disease—conditions which are all characterised by vomiting—when occurring in association with pregnancy, may give rise to intractable vomiting. These cases must therefore be excluded by careful clinical examination before the case can be considered as an example of vomiting due to pregnancy. Occasionally chronic intestinal obstruction in pregnancy on account of the obtrusive character of the vomiting has been overlooked, and the case treated as one of toxæmic vomiting, with disastrous results.

Neurotic Vomiting.—Severe and persistent *nausea* and *retching* are not infrequently met with in pregnant women of neurotic temperament ; no loss of flesh or other sign of illness accompanies it, and although troublesome the condition is of small clinical importance. But sometimes very severe *vomiting* from hysteria occurs in pregnancy. As a rule, neurotic vomiting does not lead to loss of flesh, but wasting is often associated with severe forms of neurasthenia ; and in pregnant women an alarming combination of the two symptoms of vomiting and loss of flesh is sometimes met with from hysteria. The urine, although diminished in quantity, from vomiting or from diminished intake of fluid, remains free from albumen, blood, and casts. This point is of great importance in diagnosis. The urine always contains abundant acetone, which makes its appearance very quickly, the reasons for which are stated on p. 98. Other manifestations of hysteria are often present in such cases, and even in their absence the true nature of the case may be demonstrated by its being curable by strong mental impressions, by hypnotic suggestion, or by isolation. It is well known that in women of neurotic temperament the tendency to hysterial manifestations is greatly aggravated by pregnancy. Numerous cases have been recorded in which hyperemesis gravidarum has been cured by the treatment of such local conditions as backward displacement of the gravid uterus, laceration and erosion of the cervix, etc. Now these local conditions cannot be accepted as the cause of hyperemesis, for they frequently occur in pregnant women without leading to this symptom, and hyperemesis frequently occurs when they are absent. To say that the vomiting is ' reflexly ' excited by such

pelvic lesions is an assumption for which no warrant exists. The cures recorded in such circumstances can only be attributed to 'suggestion'—*i.e.*, the mental effect produced upon a neurotic patient by the treatment adopted.

Toxæmic Vomiting.—This is toxæmia of pregnancy, in which vomiting is the prominent symptom. Only a very small proportion of the cases of excessive vomiting belongs to this class; but it is very important, for the cases are all severe and intractable, and a considerable percentage ends fatally. There are definite reasons for regarding these cases as toxæmic, which may be stated as follows:—

(1) In fatal cases changes occur in the liver and kidneys of the same nature as those found in eclampsia (Plate IV. (b), p. 101).

(2) In the later stages there may be partial anuria, the urine containing albumen, blood and casts. Acetone, diacetic and β-oxybutyric acids are, of course, present, but are of no special significance, as they occur in the urine in all varieties of prolonged vomiting.

(3) Pyrexia, rapid pulse, and convulsions are often present, as in eclampsia.

(4) The condition is curable by terminating pregnancy, except in the most advanced stages.

It is improbable that the toxæmia is of exactly the same nature as that of eclampsia, although there are many points of resemblance between them. Toxæmic vomiting occurs in the early months of pregnancy, while eclampsia is never met with before the fifth month. The clinical feature which chiefly characterises the one is vomiting, the other convulsions. Signs of renal involvement occur early in the one, late in the other. And again, according to most observers, the hepatic changes, although consisting in both cases mainly of hæmorrhage and necrosis, begin in the centre of the hepatic lobule in pernicious vomiting, in the periphery of the lobule in eclampsia. The points of resemblance justify the view that both are chorionic toxæmias; the points of difference may be due to the fact that pernicious vomiting occurs before, and eclampsia after, the full development of the placenta. The placental chorion may perhaps produce toxins of a somewhat different kind from those produced by the early chorionic membrane.

Clinical Features of Toxæmic Vomiting.—In the early stages of the disease there is little or nothing to indicate the serious nature of the condition. The normal morning sickness of pregnancy may be unusually severe, and instead of abating it becomes more and more persistent. It is, as a rule, not until severe vomiting has been in progress for some time that any definite ill-effects appear. Then vomiting begins to occur independently of food being taken into the stomach, and in addition everything swallowed is rejected, but the vomit

consists only of food and bile-stained fluid. The tongue remains clean, and the general condition is good. The next changes to appear are loss of weight and quickening of the pulse rate ; the latter forms one of the most useful indices of the severity of the case, and a pulse rate persistently over 100 is always to be regarded as of grave significance. The tongue now becomes furred, and sometimes diarrhœa appears ; sleeplessness and muscular twitchings are also sometimes met with. Severe epigastric pain is often complained of, and the vomited matter may contain blood. Abortion may occur spontaneously, and rapid disappearance of the symptoms follows the evacuation of the uterus in the earlier stages of the disease.

If pregnancy continues, the disease passes into its final phase, characterised by scanty urine containing albumen, and often blood and casts ; slight icterus is often met with ; the temperature often rises to 100° or over, although almost as frequently it will be subnormal ; the pulse rate rises to 120 or higher, and a train of nervous symptoms develops of the gravest prognostic significance, viz., restlessness, loss of memory, low delirium, and convulsions or coma. If at this stage abortion should occur little or no benefit ensues from the evacuation of the uterus, and a fatal result is almost inevitable. The mortality of toxæmic vomiting is probably 50 to 60 per cent.

Differential Diagnosis.—Cases of *associated* vomiting can be recognised only by careful clinical examination, and by bearing in mind the possibility of such a cause in every case of vomiting of pregnancy. Cases of the *neurotic* type are very difficult to distinguish from toxæmic cases in the initial stages, and usually this can only be done by watching the course of the disease and its response to treatment. In both the only symptom may be intractable vomiting with a clean tongue and a normal pulse rate ; but as a rule the neurotic cases are characterised more by nausea and severe retching than by the ejection of the actual stomach contents. Nevertheless cases of neurotic vomiting may occur in which wasting comes on from actual starvation. In such cases other signs of the neurotic temperament must be sought for, and in some cases the common 'stigmata' of hysteria, such as anæthesia of the fauces, and points of spinal tenderness, may be found. The urine is normal, except that it contains large quantities of acetone and the ammonia nitrogen may be abnormally high. The favourable effect of isolation and trained nursing often confirms the diagnosis.

The points specially to be relied upon as indications of *toxæmic* vomiting are (1) the presence of albumen and blood in the urine along with marked oliguria ; (2) a *persistently* rapid pulse rate ; (3) marked loss of flesh ; (4) furring of the tongue, signs of jaundice, and delirium. When in doubt, it is better

to regard the case as one of toxæmic vomiting and treat it as such. It will be noticed that in the later stages certain points of resemblance to eclampsia are met with in the condition of the urine and the appearance of coma and convulsions. These points must be considered in relation to the post-mortem appearances, which closely resemble those of eclampsia.

Treatment.—Before treatment is begun the greatest care should be exercised in excluding any organic disease to which the vomiting may be due, and in establishing the diagnosis of pregnancy. Time may be required to distinguish the neurotic type from the true toxæmic vomiting. All cases of moderate severity should at first be treated by confinement to bed and careful feeding, small quantities—2 to 3 ounces—of milk or some peptonised food being given every two hours. If this is not retained, albumen water alone should be given for twenty-four hours in small quantities at regular intervals, and rectal alimentation employed in addition. It may be necessary to stop all fluids by the mouth and use rectal alimentation alone for four or five days. Continuous rectal drip injections of saline and glucose (2 ounces of glucose to a pint of normal saline) form the staple elements. It is doubtful whether peptonised milk or beef extracts are of much nutritive value when given per rectum. Drugs are of little benefit, but the following may be given a trial: 1-minim doses of tincture of iodine well diluted every hour, bismuth with hydrocyanic acid, cocaine, and oxalate of cerium. In neurotic cases a quarter of a grain of morphia may be given hypodermically, followed a quarter of an hour later by a quantity of fluid food, such as egg and milk. The food will probably be retained and digested during the sleep which follows. Occasionally a hysterical case can be completely arrested in this way. Washing out the stomach will also sometimes cure this form of vomiting. Sinapisms applied to the epigastrium, and ice-bags to the spine, have been found useful. When the hysterical factor is obvious the patient should be isolated from her friends and placed in charge of an experienced nurse. In a nursing-home or hospital the vomiting usually stops at once; treatment on the foregoing lines may be continued for a day or two, but it is often a successful plan to offer the patient an ordinary meal and thus create the suggestion that she will no longer vomit.

Toxæmic cases, or cases assumed to be such, should in addition be treated by the 'eliminative method' described on p. 118. When marked signs of acidosis are present, the indication is to administer large doses of an alkaline salt, together with a readily assimilable carbohydrate substance, such as glucose. Bicarbonate of soda should be given in sixty-grain doses, per rectum if necessary, and repeated every four hours until the reaction of the urine becomes definitely alkaline.

Glucose can also be administered in the manner mentioned above.

The *obstetric* treatment consists in the induction of abortion. The evacuation of the uterus does not always arrest the vomiting ; in the most advanced stages of the disease it has little effect. Induction of abortion, if undertaken in time, should prove to be a safe and easy means of arresting the disease, but the statistics of induced abortion are extremely unfavourable. This is probably due in the main to the fact that the condition of the patient has become desperate from delay before induction is resorted to. Lepage was able to report 66 per cent. of recoveries in a series of thirty-two cases in which induction was practised, but even this high mortality compares favourably with results published by previous observers. Induction should be advised before the febrile stage is reached. If vomiting persists in spite of eliminative and dietetic treatment and is accompanied by a pulse rate of 100 or over, or by marked emaciation, and the presence of albumen in the urine, the patient's life is in great danger ; there need be no hesitation at this stage in advising that pregnancy should be ended, without waiting for the appearance of symptoms of greater gravity.

The methods by which abortion may be induced will be considered in a later section.

Acute Yellow Atrophy of the Liver

Acute yellow atrophy of the liver is an extremely rare disease. Apart from poisoning with phosphorus, chloroform, and certain other chemical and bacterial poisons, the vast majority of recorded cases have occurred in association with pregnancy. It is an acute widespread autolytic necrosis of the liver cells, characterised by jaundice, profound toxæmia, and a reduction in the volume of the liver. On section the liver presents a yellow or mottled red and yellow colour. It is most common towards the end of pregnancy, but may also occur during the first few days following delivery. The symptoms are those of the most acute form of eclampsia, but without convulsions and with the addition of jaundice. Jaundice in pregnant or recently delivered women is always a serious symptom, as it may indicate the onset of acute yellow atrophy. No treatment is known which will arrest the course of this malady.

We have next to consider certain minor disorders associated with pregnancy which may be included among the toxæmias, although their dependence upon toxæmia is, in the present state of our knowledge, a matter of assumption ; they may eventually be shown to be indications of some other condition.

Ptyalism or *sialorrhœa* is sometimes extremely troublesome in the early months during the period at which morning sickness appears ; sometimes it is associated with severe vomiting. It is not often of great clinical importance ; usually it is a neurosis, and the excessive secretion ceases during sleep. But in rare cases it is associated with rapid wasting and grave deterioration of the general health, and is believed to have a toxæmic origin. Treatment, when indicated, is by suggestion and isolation. No drug is of the least use. Ptyalism usually continues throughout pregnancy, but ceases soon after labour. *Pruritis* limited to the external genital organs is of frequent occurrence during pregnancy, and, although troublesome, is never of grave importance. Sometimes, however, general pruritus affecting the skin of the entire body occurs ; it may be associated with eruptions of erythematous or eczematous type, or the skin may be unaffected in appearance. General pruritus may lead to serious consequences from sleeplessness and exhaustion due to ceaseless irritation. Herpes sometimes of a severe type occurs during pregnancy, and has been named *herpes gestationis*. It occurs on the external genitalia and the trunk, and is very intractable to treatment. Cases have been successfully treated by eliminative methods, and it is possible that the condition is of toxæmic origin. *Mental Disturbances*.—The liability of neurotic women to exacerbations of hysteria during pregnancy has been already referred to. Minor disturbances, such as sleeplessness, restlessness, and perversions of the appetite (longings), may also be met with ; when insanity occurs it is usually in single women, and is attributed largely to mental distress and apprehension.

Backward Displacement of the Gravid Uterus (Retroversion, Retroflexion)

In the majority of cases this condition results from the occurrence of conception in a uterus which is already retroverted or retroflexed ; more rarely a normally placed uterus becomes displaced during the first or second month of pregnancy by a fall, by a violent muscular effort, or by over-distension of the bladder. Unless a history of such occurrences as these can be obtained, there is no means of distinguishing between the two modes of origin. The distinction between retroversion and retroflexion is not of practical utility, and no attempt need be made to consider them separately.

Backward displacement usually undergoes spontaneous reposition during the third month and gives rise to no symptoms. If spontaneous reposition does not occur symptoms rarely arise before the end of the third month has been passed (thirteenth week), and the symptoms which then appear are

simply mechanical in their origin. At this period the gravid uterus is nearly globular in shape, having a diameter of from $3\frac{1}{2}$ to 4 inches (Fig. 48)—*i.e.*, it is nearly as large as the pelvic cavity in the living subject. It therefore exerts pressure upon the pelvic contents, giving rise to pain and interference with the functions of the bladder and rectum. The prominent and characteristic symptom is retention of urine, either absolute or

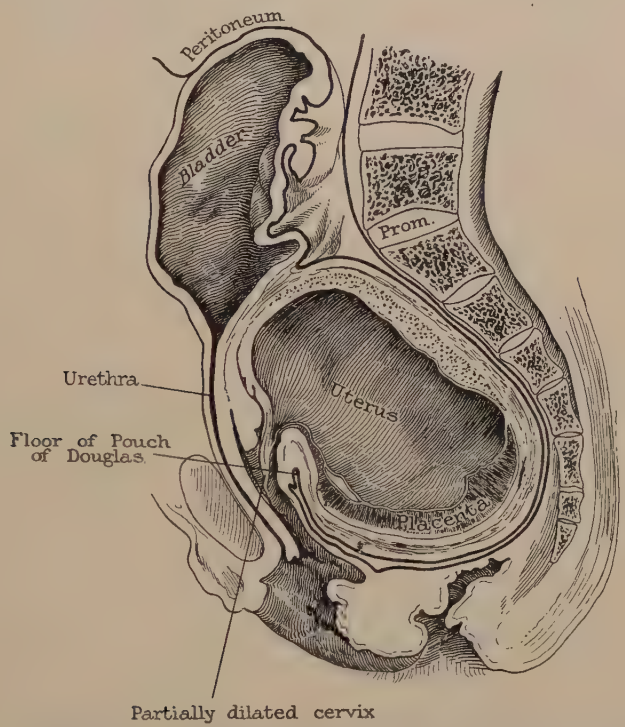


FIG. 61.—Retroflexed Gravid Uterus (three and a half to four months) with Distension and Rupture of the Bladder; Commencement of Abortion. From a Frozen Section. (Schwyzer.)

associated with continuous dribbling. Sometimes the onset of this symptom is sudden, the patient being completely unable to pass water; usually the onset is gradual, frequency of micturition passing on to urinary incontinence. The sudden onset is always associated with great pain and distress; with the gradual onset the patient may be quite unconscious of the over-distended state of the bladder, which causes no pain. There may also be rectal tenesmus, and pain in the back and posterior aspects of the legs, but these symptoms are of minor importance.

The manner in which retention of urine is set up will be understood from Fig. 61. The gravid uterus is shown completely filling the pelvic brim and cavity, and causing a certain amount of compression of the urethra against the back of the symphysis pubis. But more striking than compression is the great elongation of the urethra, which is almost double its normal length. This elongation results from two factors: (1) upward displacement of the cervix and stretching of the anterior vaginal wall, the external os being at the level of the upper border of the symphysis; (2) upward displacement of the lower part of the anterior uterine wall to which the base of the bladder is attached. These two anatomical changes cause elongation of the entire urethra; this leads to narrowing of the lumen, which in turn increases the resistance to evacuation of the bladder. If the sphincter becomes relaxed, incontinence occurs, with escape of small quantities of urine at frequent intervals ('retention with overflow'). In the figure it is seen that abortion, indicated by dilatation of the cervix, has begun. The peritoneal investment of the bladder is convoluted, and the organ is partly collapsed, rupture having occurred in the over-distended state.

Clinical Course and Results.—Backward displacement giving rise to no symptoms may be met with accidentally in the second or third month; it usually becomes spontaneously reduced as the uterus develops. While the bladder remains over-distended spontaneous reposition is impossible. In rare instances no urgent symptoms occur at all even at the critical period—the end of the third month—and the uterus continues its development in its abnormal position, giving rise to the condition known as *sacculation* of the uterus. This has been known to persist until term, and not to interfere with normal delivery. More commonly abortion takes place if the displacement remains uncorrected.

Serious results may ensue if the uterus becomes *incarcerated*. The word 'incarceration' literally means 'imprisonment,' the enlarged uterus fitting the pelvic cavity so tightly that difficulty in effecting its reposition is very great; more rarely there is some serious mechanical obstacle to reposition, such as pelvic contraction, especially of the *flat* variety (see p. 365), and peritonitic adhesions involving the uterus, which may have been in existence at the time of conception, or may have developed during the pregnancy. Such cases as these, when unrelieved, may become complicated by (1) cystitis; (2) gangrene and exfoliation of the vesical mucous membrane; (3) uræmia or surgical kidney; (4) rupture of the bladder, which is extremely rare. With any of these complications prognosis is very grave.

Diagnosis.—The occurrence of marked disturbance of the

functions of the bladder in association with three or four months' amenorrhœa should always raise the suspicion of backward displacement of the gravid uterus, and it must be remembered that troublesome frequency of micturition with slight incontinence may be the only symptoms to which the over-distended bladder gives rise. Sudden inability to pass water always brings the patient to seek immediate relief; but frequency and slight incontinence, when unassociated with pain, are often disregarded by her, and sometimes misinterpreted

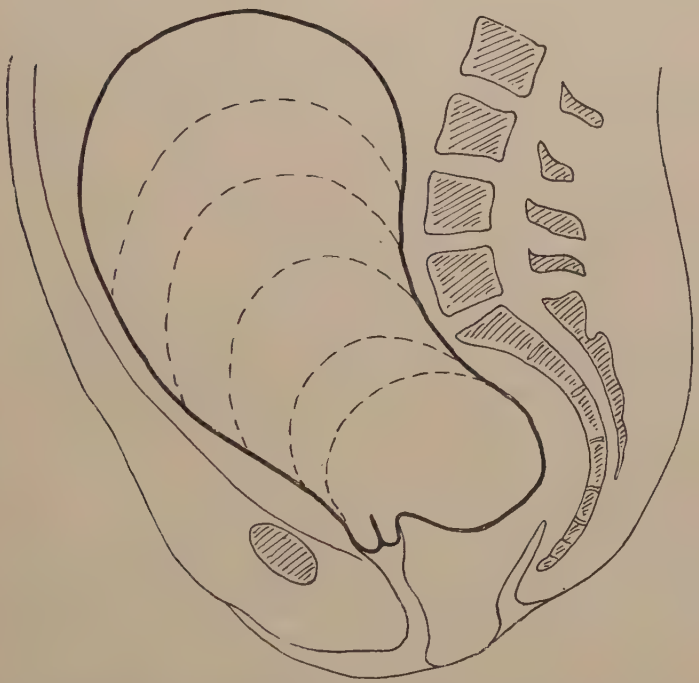


Fig. 62.—Gradual development of anterior wall of uterus in a case of Incomplete Retroflexion of the Uterus. (Galabin and Blacker.)

by her medical attendant. Careful abdominal and vaginal examination is required to determine (1) the state of the bladder, (2) the position of the uterus.

On *abdominal* examination an over-distended bladder reveals itself as a soft, insensitive, fluctuating swelling, superficial in position, and reaching well above the umbilicus in extreme cases. Its height alone will serve to distinguish it from the gravid uterus at the third or fourth month. Any doubt will, of course, be dispelled by passing the catheter. Until the bladder has been evacuated, nothing further can be detected on abdominal

examination. Signs of activity in the breasts should be noted as being presumptive of pregnancy.

On *vaginal* examination the conditions will be found which are shown in Fig. 61. The first point which attracts attention is the forward bulging of the posterior vaginal wall, due to depression of the floor of the pouch of Douglas, and filling up of the sacral hollow by the body of the uterus, which is felt as a smooth, tense, elastic swelling. In consequence the direction of the vaginal canal is altered so that it passes from below upwards and a little forwards, instead of upwards and backwards. The next point to be noticed is the inaccessibility of the cervix, which cannot be found at the usual level, but lies high up behind the symphysis pubis. Often the posterior lip alone can be reached, and sometimes the cervix is entirely inaccessible to touch without employing anæsthesia for the examination. After evacuation of the bladder the bimanual examination will show that the swelling felt through the posterior vaginal wall is the gravid uterus, and examination per rectum will allow of much more complete palpation of the displaced uterus than the vaginal examination. Confirmatory signs of pregnancy may be found in softening of the cervix, and purple discoloration of the mucous membrane of the vulva. Finally, an attempt should be made to estimate the mobility of the uterus by endeavouring to lift it upwards and forwards in the pelvic axis with the examining finger. The presence of pelvic contraction should not be overlooked as a cause of incarceration; adhesions are very difficult to diagnose, and their presence will not, as a rule, be suspected until it is found that some unexpected obstacle to replacement exists.

Differential Diagnosis.—There are only two conditions which may be said closely to resemble retroversion of the gravid uterus—viz., *pelvic hæmatocele* (almost always due to extra-uterine gestation) and a *fibroid tumour in the posterior uterine wall.* The former will be considered in a subsequent section (see p. 165). With regard to the latter, the differential diagnosis is easy if the fibroid uterus is not gravid, but very difficult if pregnancy has occurred; in the latter case the physical signs may so closely resemble those of a retroverted gravid uterus as to deceive the most experienced clinical observer. The following symptoms usually afford valuable aid in distinguishing these conditions, as may best be indicated in the table on p. 131.

The great majority of fibroids are hard and quite unlike the gravid uterus in consistence, but sometimes these tumours become softened from œdema or cystic degeneration; and although multiple fibroids cause the outline of the uterus to become irregular, a single interstitial or submucous growth will cause a symmetrical enlargement not unlike that of pregnancy. Softening of the cervix is often delayed when pregnancy occurs

in a fibroid uterus. These facts, together with the tendency of fibroids occupying the posterior uterine wall to occasion retention of urine, are the chief causes of the difficulties in diagnosis.

Other swellings, such as a small ovarian cyst, may be found occupying the pouch of Douglas and displacing the cervix forwards against the symphysis pubis. They seldom, however, cause retention of urine, for the reason that they do not occasion that elongation of the urethra to which retention is largely due in the case of the retroverted gravid uterus. The differential diagnosis can usually be made by localising the uterus, which will be found to be of normal size and to lie in front of the swelling, and distinct from it. None of the signs or symptoms of pregnancy will be met with.

Treatment.—Cases of backward displacement sometimes come under observation before the functions of the bladder have

I. Retroverted Gravid Uterus.	II. Fibroid in Posterior Wall.	III. Fibroid in Posterior Wall + Pregnancy.
1. Amenorrhœa	Normal menstruation or menorrhagia	Amenorrhœa or slight irregular hæmorrhage
2. Signs of pregnancy in Breasts (primigravida), Cervix, and Vulva	Occasionally secretion in Breasts No signs of pregnancy in Cervix and Vulva	Signs of pregnancy in Breasts (primigravida), Vulva, and Cervix
3. Retention of urine	Retention of urine	Retention of urine

been interfered with ; sometimes the condition is discovered by accident, sometimes the patient comes complaining of backache. In the absence of symptoms, treatment is not required ; no attempt should be made to replace the uterus ; the manipulations required are painful and sometimes difficult ; abortion not infrequently follows them even when they are successful ; and, in addition, replacement is unnecessary. The patient should be put to bed and kept resting for a few days. She should be directed to lie prone on her face for several hours at a time, and, if possible, to sleep in that position. Symptoms such as backache always disappear, and in most cases about the end of the third month the uterus will rise spontaneously out of the pouch of Douglas into the normal position. A ring pessary may be introduced to prevent recurrence of the displacement.

After retention of urine has occurred, the best method of treatment is rest in bed with the regular use of the catheter three times in 24 hours ; in the majority of cases spontaneous ascent of the uterus occurs after three or four days ; in others, however, some method of replacement may be required, but resort should not be made to these methods until the expectant

method has failed. There is no obstruction to the passage of a catheter, but it has to be passed in a greater distance because of the elongation of the urethra ; a soft rubber catheter is the most suitable.

Methods of Replacement.—The two chief methods made use

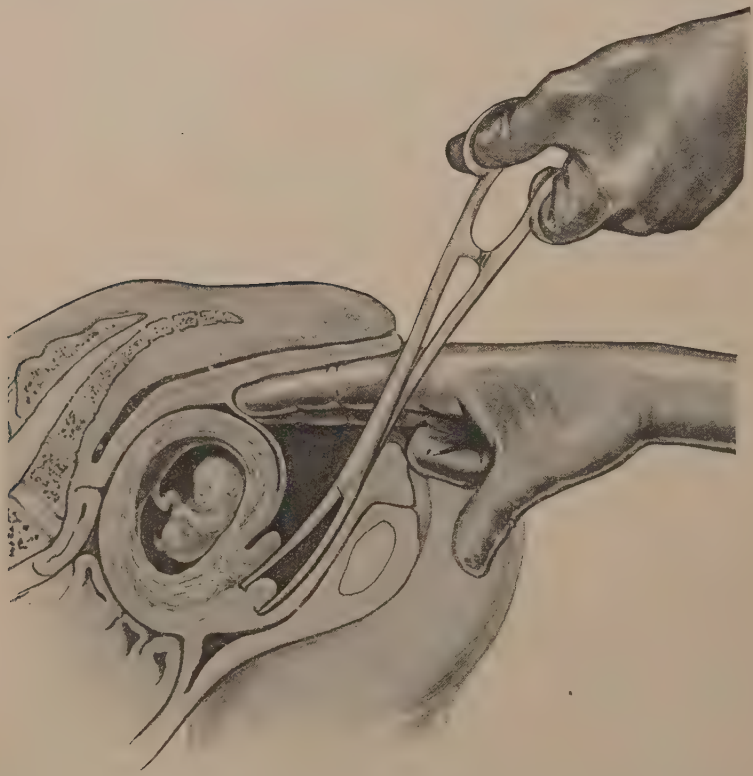


Fig. 63.—Replacement of Retroverted Gravid Uterus by Manipulation in Genu-Pectoral Position.

of are : (1) manipulation aided by posture, anæsthesia, or prolonged rest ; (2) continuous pressure.

(1) *Manipulation.*—The simplest application of this method is to place the patient in Sims's position (Fig. 180) and, the bladder having been evacuated, to endeavour to push the fundus upwards and forwards in the direction of the axis of the pelvic brim ; this may be done with two fingers passed into the vagina, or with the index finger in the vagina and the middle finger in the rectum, which allows of pressure being more effectively applied to the retroverted fundus. Further aid may also be obtained by seizing the anterior lip of the os externum

with a volsella and drawing it downwards while the fingers push the fundus upwards. This, however, will not succeed unless the patient is tolerant of pain and will avoid straining. When the fundus has been raised above the pelvic brim, the cervix should be pushed back towards the sacral hollow and the body drawn forwards towards the pubes with the external hand. Precisely the same manœuvre may be attempted with the patient in the knee-elbow or the knee-chest (genu-pectoral) position (Fig. 63), which brings in the aid of gravity to a greater extent, the uterus tending to fall towards the dependent abdominal walls. If an anæsthetic is administered, so as to abolish completely the muscular reflexes, manipulation will often succeed after being employed unsuccessfully without it. The position of the patient is unimportant when under anæsthesia. Even when manipulation fails at first, it may succeed after a few days' rest in bed, and the use of saline purgatives.

In Sims's position the patient lies on her left side with the left arm behind her, and both knees drawn up to the abdomen, the right higher than the left. The knee-elbow and knee-chest positions will be more fully described in a later section (see p. 361).

(2) *Continuous Pressure.*—This method is applied by passing into the vagina the hydrostatic dilator known as the de Ribes bag (see p. 594), distending it with air or water (preferably the former), and allowing it to remain for a period of six hours at a time. This continuous elastic pressure from below, when applied intermittently for a few days, sometimes succeeds after manipulation has failed, but it causes considerable pain.

If these methods fail to effect reposition of the uterus, neither induction of abortion nor abdominal operation to free presumable adhesions is to be undertaken. The patient is kept in bed and the bladder treated; so long as there is retention of urine the catheter is passed at regular intervals and urinary antiseptics are administered. The bladder in time will recover its function. The development of the uterus will gradually obliterate the posterior pouch and, during the first stage of labour when the lower uterine segment becomes pulled up, the condition will have become fairly normal, and there is good hope of spontaneous delivery taking place.

Anteflexion of the Gravid Uterus.—During the last three or four months of pregnancy, when the uterus is imperfectly supported by the lax abdominal walls so often found in a multipara, the fundus tends to fall forwards, producing unusual protrusion of the abdomen. This may become exaggerated by the uterus passing between the recti muscles, when they have become separated from one another by a distinct interval; the uterus being then supported only by the cutaneous structures of the abdominal wall, the fundus may come to lie at a lower

level than the symphysis pubis, producing the condition called *pendulous belly* (Fig. 64). The same condition may result from, or be exaggerated by, extreme pelvic contraction, preventing the descent of the fœtus into the pelvic brim ; or spinal curvature, reducing the length of the abdominal cavity and displacing the uterus forwards. It naturally causes considerable discomfort when the patient is in the erect position, and if uncorrected may lead to rupture of the uterus during labour. Occasionally an atypical form of anteflexion results from previous fixation of the uterus by hysteropexy or vaginal fixation, and serious obstruction in labour sometimes results. The *treatment* during pregnancy consists in wearing a strong well-fitting abdominal belt.

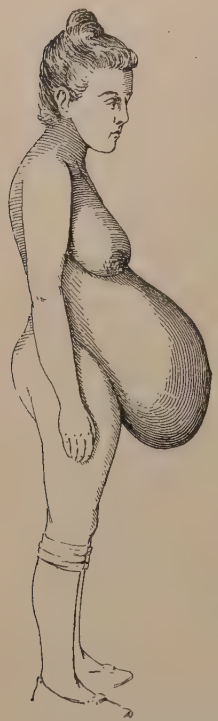


FIG. 64.—Anteflexion of the Gravid Uterus: Pendulous Belly. (Ribemont-Dessaignes and Lepage.)

Prolapse of the Gravid Uterus.—A completely prolapsed uterus (procidentia) very rarely becomes gravid. If pregnancy should occur, spontaneous ascent usually takes place about the third month ; but the uterus may become irreducible, when spontaneous abortion will almost inevitably occur. Minor degrees of prolapse of the uterus are frequently met with in pregnancy ; they only require treatment during the first three or four months, as after this period the uterus has risen into the abdomen and is supported by the pelvic brim. A ring pessary of suitable size is generally successful.

Hernia of the Gravid Uterus.—Very rarely the uterus forms part of the contents of an inguinal hernia, and in that position it has been known to become gravid. This condition is naturally more likely to affect a bicornute uterus, one horn being drawn into the hernial sac. Sometimes also the gravid uterus may enter the sac of an umbilical or a ventral hernia ; but this is rare, as the uterus, by the time it reaches the level of the hernial aperture, is usually too large to enter the sac.

Malformation of the Uterus and Pregnancy.—Few malformations of the uterus possess any obstetrical significance.

Double Uterus (Uterus didelphys ; Uterus bicornis).—When pregnancy occurs in one half of a double uterus, the non-pregnant half undergoes sympathetic enlargement and a complete decidual membrane is formed within it. The course of preg-

nancy and labour may be unaffected, and although the portio vaginalis and vagina may be duplicated, the condition often passes unrecognised. In binovular twin pregnancy an ovum may be lodged in each half. Occasionally the non-pregnant horn may block the pelvis and obstruct delivery, necessitating Cæsarean section.

Bicornute Uterus with Rudimentary Horn.—Sometimes a bicornute uterus possesses only one fully developed horn, the other being rudimentary ; as a rule the lumen of the rudimentary horn has no connection with the fully developed one (Fig. 65). Pregnancy may occur in the rudimentary horn by

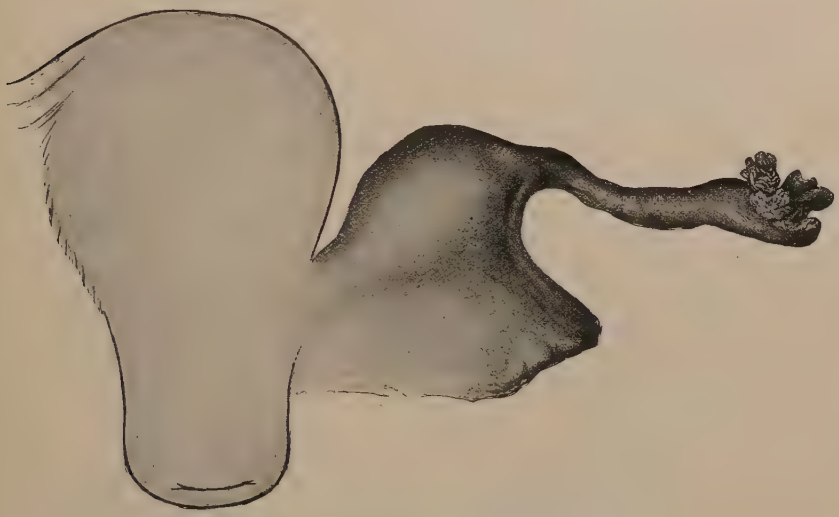


FIG. 65.—Accessory Horn attached to the Left Side of a well-formed Uterus.

(Diagrammatic. The uterus was not removed.) The round ligament is seen coming off from the outer side of the horn. There was no communication between the accessory horn and the normal uterine cavity.

' external wandering ' of the spermatozoa ; the fertilised ovum may come from the ovary of the same side as the rudimentary horn, or from the opposite one ; in the latter case it must cross the pelvic cavity to enter the abdominal ostium of the rudimentary horn. Pregnancy in this position usually ends in rupture of the gravid horn, and is mistaken clinically for tubal gestation.

Pressure Symptoms

In the lower extremities and upon the lower part of the abdominal wall, *anasarca* usually appears to a slight extent during the last two months of a first pregnancy, and sometimes in later pregnancies also. It is due mainly to impeded venous

return from these parts, the obstacle being the compression exerted by the gravid uterus upon the iliac veins at the pelvic brim. The labia majora may also become œdematous, and form swellings of considerable size even when there is no albuminuria. Occasionally only one labium or one leg is affected with anasarca. *Varicose veins* often appear in the lower extremities, and in the vagina or vulva during pregnancy, being caused in the same way as anasarca. Spontaneous rupture of a varicose vein during pregnancy sometimes occurs and leads to severe or sometimes to fatal bleeding. When the ruptured vein is in the vaginal wall the case is very likely to be mistaken in the first place for one of ante-partum hæmorrhage, and only a careful search with the aid of a speculum will lead to a correct diagnosis. Vulval varices may give rise to serious bleeding from injury during pregnancy, or from rupture during labour. *Hæmorrhoids* are often produced or aggravated during the later months of pregnancy. *Cramp* in the muscles of the legs, either spontaneous or when walking, is often very troublesome during the last few weeks, and is probably due to pressure upon the nerves of the lumbosacral plexus.

The *treatment* of these pressure symptoms consists, in the main, of rest in the horizontal position. In cases of œdema careful examination of the urine must of course be made, as, if albumen is present, the aspect of the case is entirely altered. Operations upon varicose veins or hæmorrhoids should not be performed during pregnancy, as continuation of the pressure prevents a satisfactory result and after labour they either disappear or are greatly diminished.

Uterine Moles

The term ' mole ' is applied to an ovum destroyed by pathological conditions affecting its coverings during the early months of gestation. Two kinds are recognised, the *Blood Mole* and the *Vesicular Mole*, and both may occur in either uterine or extra-uterine gestation. Moles are often colloquially termed ' False Conceptions.'

I. **The Blood Mole** (Synonyms: Carneous or Fleshy Mole, Hæmatoma Mole).—The blood mole results from the destruction of the ovum by progressive or recurrent hæmorrhage usually but not invariably occurring before the formation of the placenta—*i.e.*, during the first three months of pregnancy. The general structure of the ovum at this period is shown in Figs. 13 and 22. It is completely enveloped in the thick, very vascular, decidual membrane; the chorion is separated from this membrane by a narrow space continuous around the whole ovum, termed the chorio-decidual space; this space contains maternal blood and is traversed by the delicate branching villi which spring from the outer surface of the chorion, and some of

which are loosely attached by their tips to the decidual surface. The morbid process starts in hæmorrhage from maternal vessels into the decidual tissues, followed by extravasation of blood into the chorio-decidual space, which will break up and destroy the delicate villi at the affected spot (Fig. 66). A sudden and extensive hæmorrhage of this kind would no doubt cause rupture of the decidua capsularis, or complete detachment of the

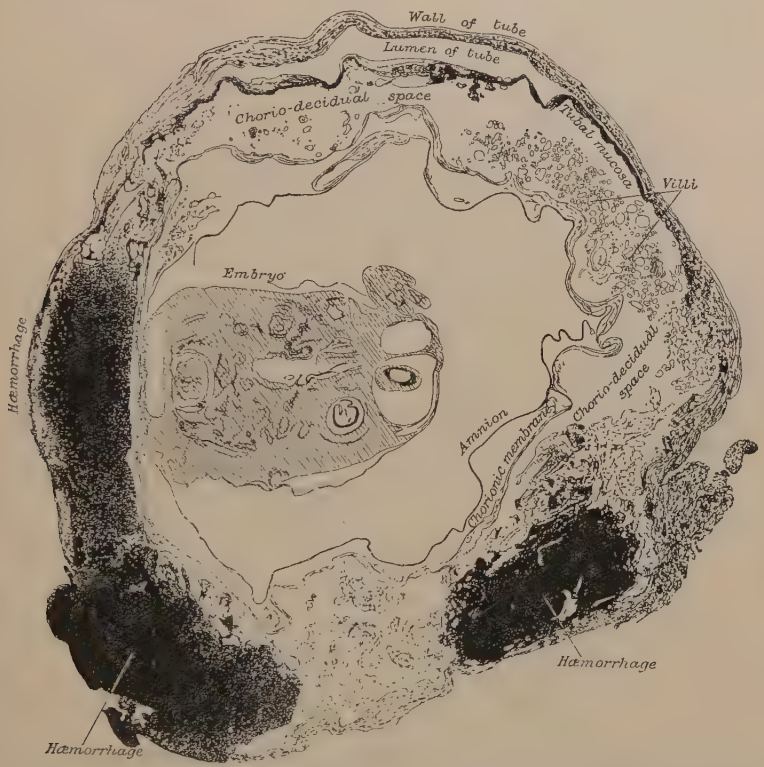


FIG. 66.—Tubal Pregnancy: Section of the Ovum *in situ*, demonstrating the Early Stage of Formation of a Blood Mole. Hæmorrhage has occurred into the Chorio-Decidual Space, breaking up large numbers of Villi. (Couvelaire.)

ovum, both of which accidents would quickly lead to abortion. But the blood mole is formed by repeated slight hæmorrhages or by a slowly progressive hæmorrhage, which does not cause rupture of the protective decidual covering of the ovum. The effused blood is free to surround the ovum more or less completely, by following the chorio-decidual space; hæmorrhage sometimes starts independently at different spots (Fig. 66). The result is the more or less complete destruction of the

chorionic membrane and its villi. The amnion, being very elastic, is able to resist the external pressure to which it is subjected ; consequently the amniotic sac is usually found free from blood in these cases. The embryo perishes and may be completely absorbed ; sometimes it remains, and is found more or less disorganised by maceration in the liquor amnii. The effused blood is usually unequally distributed around the ovum,

FIG. 67.—Tubal Pregnancy : Section of the Ovum *in situ*, demonstrating the Late Stage of Formation of a Blood Mole. (Couvelaire.)

and forms an irregular series of abrupt polypoid elevations (Fig. 68), covered by the amnion, with deep intervening sulci : this causes marked distortion and narrowing of the amniotic cavity.

In Figs. 66 and 67 two stages in the formation of a blood mole are shown ; the drawings were made from cases of tubal gestation, and therefore they illustrate primarily the mode of formation of a tubal mole ; but the process is probably identical

with that which occurs in the uterus. In Fig. 66 hæmorrhage has occurred at two distinct areas of the chorio-decidual space ; the effused blood is bounded internally by the unruptured chorionic membrane, and within this by the amnion. As there is little or no decidual formation in the gravid tube, the hæmorrhage appears to be limited externally by the tube wall. The amniotic sac and the embryo appear to be unaffected. In Fig. 67 a later stage of the process is shown. Extensive hæmorrhage has occurred, which entirely surrounds the ovum ; it is

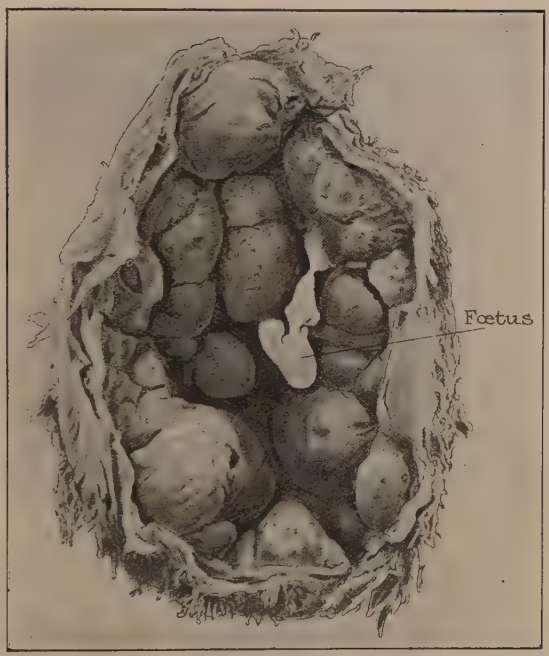


Fig. 68.—Fleshy Mole : Four Weeks' Gestation, retained until the Seventh Month. (Charing Cross Hospital Museum.)

limited internally by the amnion alone, and the amniotic sac is small and distorted, but still contains a trace of the body of the embryo ; the chorionic membrane has been completely destroyed. Irregular protuberances with intervening sulci are seen on the amniotic aspect. The hæmorrhage is almost entirely maternal in origin ; no doubt some admixture of fœtal blood also occurs, but its amount must be inconsiderable, owing to the small size of the embryo at this period.

Opportunities of examining a uterine mole *in situ* seldom occur, but the post-mortem uterus represented in Fig. 69 shows that the general relations of the uterine mole are precisely

the same as those just described as found in the tubal mole. The chorio-decidual space is the chief seat of the hæmorrhage which is irregularly distributed around the whole ovum.

An ovum thus destroyed may be retained *in utero* for many weeks or months ; the effused blood then undergoes consolida-

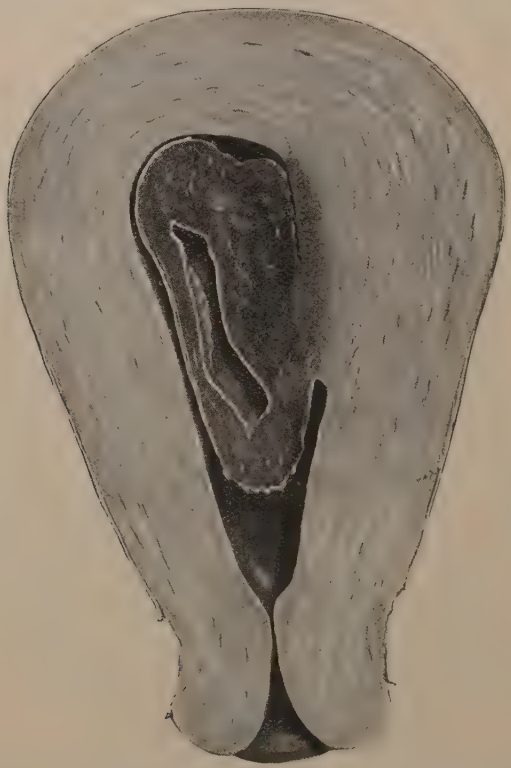


Fig. 69.—A Missed Abortion *in situ :* the Amniotic Sac has shrunk from Absorption of Fluid, and the Fœtus has disappeared. Extensive Hæmorrhage has occurred between the Amnion and the Outer Wall of the Ovum. Partial Separation of the Ovum from the Uterine Wall has occurred in the upper part.

tion from absorption of its fluid constituents, and the wall of the dead ovum becomes firm and ' fleshy ' in consistence (carneous or fleshy mole, Fig. 68). On section, the wall of the carneous mole is sometimes seen to be partially laminated, indicating that it has been formed by repeated hæmorrhages ; sometimes strands of fibrous tissue traversing it can be recognised, indicating remains of the chorion. On microscopic examination

degenerated chorionic villi, imbedded in blood-clot, will be found in it.

In a certain number of fleshy moles there is a marked disproportion between the size of the amniotic cavity and the stage of development of the fœtus. This is well shown in Fig. 68, where the fœtus measures 8 mm. in length (three to four weeks), while the amniotic sac measures $2\frac{1}{2}$ inches by $2\frac{1}{2}$ inches (nine to ten weeks). A healthy fœtus is never found in a carneous mole. Occasionally the fœtus has disappeared altogether; more commonly it is disproportionately small, and is shrivelled to an extent which obscures all its characteristic features. The umbilical cord is similarly altered. These changes follow the death of the fœtus and are due to *autolysis*, a process by which the protein constituents of the tissues are converted into soluble substances, which are taken up into the liquor amnii and thus disappear. Marked disproportion in size between the fœtus and the amniotic sac is probably due in part to autolysis of the fœtal tissues, and in part to an excessive production of liquor amnii (hydramnios). It is possible that the hydramnios was present in these cases before the formation of the mole began, the hæmorrhagic process being started by the stretching to which the decidua was subjected by the abnormally large ovum. This point is, however, still the subject of dispute, and in any case hydramnios is not to be regarded as an essential factor in the production of a blood mole.

We can only speculate upon the conditions which give rise to hæmorrhage in the early ovum. Syphilis, chronic Bright's disease, and endometritis are believed to be concerned in its production, but upon inconclusive evidence. The great vascularity of the decidual membrane, the imperfect external support furnished by the decidua capsularis at this period, and the delicacy of the young chorionic attachments, make it probable that even in the case of a healthy ovum slight traumatic disturbances may start the process, or, as the result of abnormal activity, the trophoblast may penetrate deeply into the uterine muscle and open up blood-vessels large enough to cause sufficient hæmorrhage to destroy the ovum.

The *symptoms* which attend the formation of a uterine mole are indefinite. In most cases a train of symptoms, to be described later on as those of 'threatened abortion,' occur, which subside, and then nothing else is noted until the ovum is cast off. This event, which may take place within a few weeks, or be delayed for many months, is known as a 'missed abortion.' The process does not differ in any respect from that subsequently to be described as 'inevitable abortion.' The *diagnosis* is naturally a matter of some difficulty, and can really only be solved by the expulsion of the mole. From the clinical standpoint these cases come under observation as cases of

abortion, and are to be treated as such. Interference is seldom required, but if the uterine discharge should become offensive (infection of the ovum), the treatment consists in dilating the cervix and clearing out the uterine contents in the manner described under the treatment of abortion.

II. **The Vesicular Mole** (Synonyms: Hydatidiform Mole; Hydatidiform Degeneration of the Chorion).—This condition

FIG. 70.—Vesicular Mole (Diagrammatic): the Entire Chorion is affected by the Disease; the Amniotic Sac is seen in the centre. (Bumm.)

is a disease of young chorionic villi, characterised by the formation of immense numbers of irregular clusters and chains of cysts which vary in size from extreme minuteness up to $\frac{4}{5}$ inch in diameter. Cases have, however, been recorded in which the largest vesicles measured $1\frac{1}{2}$ inches in long diameter. The superficial resemblance of these cysts to hydatids originated the name by which this condition is known, but it must be understood that the hydatidiform mole has really nothing in common

with echinococcal cystic disease. The naked eye appearance of this mole is so characteristic that its recognition is very easy.

The disease has been observed as early as the third week of pregnancy, and in such cases the whole of the chorionic membrane, being villous, may be affected in the manner represented in Fig. 70. It probably begins in all cases at a comparatively early period, for it is quite exceptional for any trace of the fœtus or the amniotic sac to be found. As a rule the contour of the

FIG. 71.—Vesicular Mole *in situ*. The Uterus was removed by Supra-vaginal Hysterectomy. (Haig Ferguson.)

ovum is completely lost, and a mass of vesicles is formed, having no definite arrangement whatever and assuming the contour of the distended uterine cavity. The formation of vesicles may be so abundant as to produce a mass weighing 4 to 5 pounds. The general relations of the mole are well shown in Fig. 71, which represents the mole as seen *in situ*, the uterus having been removed by supra-vaginal hysterectomy. The cystic villi are closely packed together, and the interstices between them are filled with blood derived from the maternal

decidua. The villi are attached to the uterine wall in the greater part of its extent ; on the right of the uterus, however, a

FIG. 72.—Placenta with extensive Hæmorrhage and Vesicular Degeneration of the Chorion. Note the Cysts imbedded in Blood-clot. (Charing Cross Hospital Museum.)

narrow space filled with blood-clot lies between the mole and the uterine wall ; this represents the *decidual space*. The internal os is partly dilated, allowing the lower pole of the cystic mass to protrude into the cervical canal.

Occasionally the disease may begin at a later period when the formation of the placenta is advanced, and the greater part of the chorion is non-villous. The degenerative changes are then usually partial, and affect a portion of the placenta only, so that the general shape of the organ may be retained and the body of the fœtus be recognisable. This is well illustrated in Fig. 72, which represents a placenta infiltrated by hæmorrhage and partially affected by vesicular degeneration. A considerable

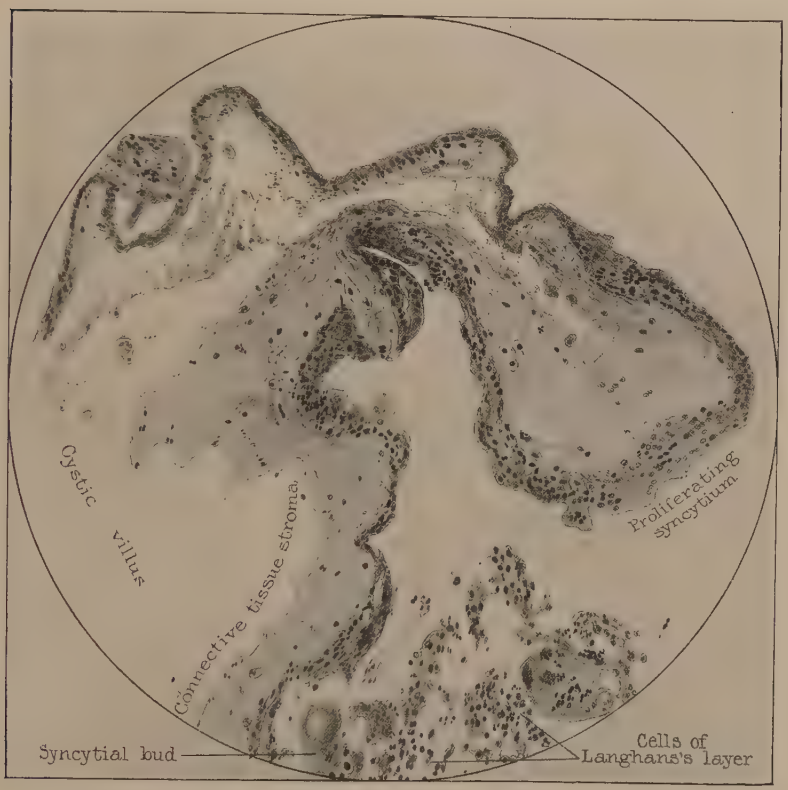


FIG. 73.—Vesicular Mole: Section through a Chorionic Villus.

number of instances has now been recorded in cases of extra-uterine gestation.

The vesicles themselves are oval or globular grape-like bodies, pale yellowish in colour, and semi-translucent. Each vesicle is stalked, the pedicle being delicate and short. The vesicles may be arranged in chains, or in clusters of irregular shape; when pricked or incised they exude a thin fluid. The decidua in cases of vesicular mole is usually abnormally thick, and shows considerable round-celled infiltration on microscopic examina-

tion. This may, perhaps, be regarded as a defensive change which enables the decidua to offer greater resistance to the eroding action of the chorionic epithelium, and thus to protect the uterine wall against excessive penetration.

The microscopic characters of the vesicles present the curious association of abnormally active proliferation of both the syncytial and cellular layers of the chorionic epithelium with degeneration of the connective-tissue stroma. The vesicles all possess a complete epithelial wall. In the larger vesicles the stroma and the blood-vessels are completely destroyed, and only a few degenerated nuclei persist ; the contents are entirely fluid. In the smallest vesicles the stroma may be fairly normal ; in those of medium size a layer of altered and compressed connective tissue may be found immediately under the epithelium, the centre of the vesicle containing only fluid (Fig. 73). Mucoid (myxomatous) degeneration was originally supposed to be the nature of these changes in the stroma, but it has now been established that the fluid found in the vesicles contains no mucin ; simple œdema or some other form of colliquative necrosis is therefore the probable cause. The epithelial covering of many vesicles shows remarkably active proliferation of the syncytial layer. In others the epithelium shows no abnormal changes whatever. In Fig. 73 are seen numerous buds and processes springing from the syncytium, and also isolated sections of such processes springing from neighbouring villi (syncytial buds). The change in both the epithelium and the stroma will be best appreciated by comparing Fig. 73 with Fig. 24, representing the same structures in a young normal villus. Unusually active proliferation of the cells of Langhans is also generally found. This abnormal epithelial proliferation, although not of universal distribution, forms a characteristic feature of these moles.

An important result of this abnormal activity on the part of the chorionic epithelium is that it possesses powers of penetrating the uterine wall which exceed those of normal villi. The eroding properties of this tissue have been already referred to in connection with the normal ovum. It has been generally believed from clinical observations that the cystic villi eroded the uterine wall to an unusual extent, causing dangerous thinning. A few cases have been recorded in which a mole was examined *in situ* after the removal of the uterus from the body. These exact observations do not support this view, for the uterine wall has not been found abnormally thin in any instance. But there is no doubt that in certain cases the eroding power of the villi is so great as to cause spontaneous perforation of the uterine wall, leading usually to death from hæmorrhage or peritonitis. This variety is known as the *perforating* or *malignant hydatidiform mole ;* it is closely allied in histological

characters to chorion-epithelioma, and is frequently followed after an interval by the appearance of this formidable new growth (see p. 531). The property of destroying healthy tissues is one of the chief characteristics of malignant disease, and quite justifies the term 'malignant' being applied to this form of mole. With the remarkable activity of the chorionic epithelium must be contrasted the fact that the degenerated villi are completely devascularised and the embryo destroyed. This fact well illustrates the truly parasitic nature of the degenerated villi. They receive no blood supply from the fœtus, but are nourished by the maternal blood with which they are in contact, and are thus enabled to grow and to proliferate. It has been already pointed out that the probable source of the nutrition of healthy chorionic villi is also the maternal blood of the intervillous spaces. In the vesicular mole there is probably no true intervillous circulation; *i.e.*, the maternal blood does not flow into and out of the system of intervillous spaces. At the same time a considerable amount of maternal blood is found between the villi, upon which their nutrition mainly depends, as there are no fœtal vessels in the villi capable of bringing maternal blood to them from the uterine wall. This blood is extravasated from vessels opened up by the active trophoblast penetrating the uterine muscle.

Nothing is definitely known as to the *causation* of the hydatidiform mole, though there has been much speculation about it. Some authorities believe that an unhealthy condition of the decidua induces the morbid change in the chorion, but others consider that it arises primarily in the chorion itself. It appears to be more reasonable to regard it as an embryonic disease, and this view is supported by the fact that in twin pregnancy it sometimes affects one ovum only. If the cause lay in the decidua, both ova would certainly be affected. It may occur at any time in the reproductive period, but is most commonly met with in the decennial periods 20 to 30 and 40 to 50. It is a distinctly rare condition, occurring probably in about 1 in 2,000 to 2,500 pregnancies.

Lutein cysts of the ovary occur in association with vesicular moles with such frequency that a causal connection between the two may be considered probable. Both ovaries are usually affected and are converted into polycystic tumours; the individual cysts are small and are lined by one or more layers of lutein cells, and lutein cells are widely distributed throughout the ovarian stroma. It has accordingly been suggested that perverted ovarian activity may prove to be an important factor in the production of these moles, but in the meantime it cannot be said that this theory has been satisfactorily proved. The fact that lutein cystomata have been observed gradually to

decrease in size and ultimately to disappear within a few months after the expulsion of the mole indicates that there is a relationship between the two processes.

Clinical Features.—Two symptoms are commonly met with in this condition: (1) undue enlargement of the uterus; (2) hæmorrhagic discharge. They always begin in the *first half* of pregnancy.

(1) Undue enlargement of the uterus, although usual, is not invariably found. Occasionally the size corresponds to the presumptive duration of pregnancy: occasionally the uterus is disproportionately small. In the great majority, however, it is disproportionately large; thus the fundus may extend up to the umbilicus three months after the cessation of the last regular monthly period; a less pronounced disparity than this is, however, more common. But it must be remembered that over-enlargement of the uterus at the third or fourth month may occur from other causes. The large uterus occupies the normal mesial position, and not infrequently reaches considerably higher than the umbilicus. It possesses a peculiar doughy consistence. The fœtal heart-sounds cannot be heard, even when the uterus is of the size of six or seven months' pregnancy, because there is no fœtus. Vesicular degeneration sometimes, however, in a twin pregnancy affects one ovum only, and then of course the heart of the surviving fœtus may be heard. As a rule intermittent contractions cannot be felt.

(2) The discharge usually appears during the third or fourth month, *i.e.*, at a time when the disease has been already in existence for some weeks. It is commonly small in amount, more or less continuous, reddish or reddish-brown in colour, and unattended by pain. Severe hæmorrhage is rarely met with except during the process of abortion, when it may be very profuse. In rare instances the discharge may possess characters which are pathognomonic, detached vesicles being found in it; but this is uncommon and must not be anticipated.

The over-enlargement of the uterus is of course due to the bulk of the diseased ovum, which may be enormous; its peculiar consistence is due to the absence of the amniotic fluid sac, which gives to the normal gravid uterus its characteristic elasticity. The hæmorrhage is probably occasioned by the detachment of vesicles from the uterine wall. After the hæmorrhage has persisted for a variable period, spontaneous abortion almost always occurs.

The general condition of a patient with a vesicular mole is often unfavourably affected to an extent not to be accounted for by the amount of hæmorrhage which has occurred. Morning sickness is often unusually severe, and toxæmic symptoms of a mild type are sometimes recognised. In rare instances a vesicular mole may be associated with pre-eclamptic toxæmia.

In a certain proportion of cases, at present undetermined, chorion-epithelioma supervenes, either immediately upon the evacuation of the mole or after an interval.

Diagnosis is often uncertain, and can only be settled by the discovery of vesicles. In the absence of this sign it may be said that marked over-enlargement of the uterus and the general signs of pregnancy, except those indicating the presence of a fœtus, are strongly suggestive of a hydatidiform mole. A radiogram, by revealing the presence or absence of a fœtus, will settle the diagnosis between normal pregnancy and vesicular mole in cases of doubt.

Treatment.—This consists in all cases in artificial evacuation of the uterus. Spontaneous abortion of a hydatidiform mole is a very long and tedious process, resulting in considerable hæmorrhage ; being almost invariably incomplete, it must be terminated by interference. The uterus in these cases appears to be unable to expel its contents, and it is therefore best, when the diagnosis has been made, to evacuate it without delay. This procedure is fully described in connection with the induction of abortion (p. 584). Rapid evacuation of the uterus with the finger or ovum forceps is so liable to be accompanied by violent hæmorrhage that it is advisable to employ a slow method of emptying the uterus. If there is no dilatation of the cervix one or more laminaria tents should be inserted, and if this does not provoke contractions the uterus must be stimulated to empty itself by other means, such as packing the cervix and vagina with sterile gauze and the administration of pituitary extract. If the patient is bleeding profusely when first seen and the cervix is dilated, considerable masses can be squeezed out by pressure from above, and uterine action can be stimulated by a hot intra-uterine douche and the administration of pituitary extract. After expulsion of the mole the uterus should be explored with the finger to ensure that no part of the mole has been left inside, after which the uterine cavity should be thoroughly douched with a weak antiseptic solution. There are special risks in the puerperium of sepsis, sub-involution, and, remotely, of the development of chorion-epithelioma.

Owing to the latter risk, special attention during convalescence should be paid to the condition of the lochia ; if tissue-debris is recognisable in the lochia, or if the red discharge should persist for more than a week, curetting should be performed. If undertaken about ten days after the evacuation or abortion, there is little risk of perforation, and it is of course of prime importance, in regard to the prognosis, that living elements of the mole should not be left attached to the uterine wall. It is the practice of some obstetricians to repeat the curetting three months later as a further precaution.

Decidual Endometritis

Acute decidual endometritis has been observed in cases of ascending gonorrhœa in pregnant women, the gonococcus having been demonstrated in the decidual membrane. So far as we know, this is the only variety of acute inflammation of the decidua arising *spontaneously* during pregnancy; but acute septic inflammation from operative interference and attempts at criminal abortion may, of course, also be met with. *Chronic* decidual endometritis is more common, and is believed to result from implantation of the ovum upon an unhealthy endometrium. The membrane is unusually thick and fleshy, and often shows numerous small cysts beneath the epithelium, which arise from irregular dilatation of the deep parts of the uterine glands. Although decidual endometritis is undoubtedly a genuine cause of abortion, its clinical recognition is impossible in the present state of our knowledge; diagnosis can only be made from examination of the membrane after its discharge from the uterus.

Hydrorrhœa Gravidarum and Decidual Endometritis.—Hydrorrhœa gravidarum is the term applied to a condition in which a discharge of watery fluid from the gravid uterus occurs intermittently in considerable amount from the second or third month of pregnancy, and may continue to term. In some cases a small amount of blood is mixed with the watery fluid. It is an extremely rare condition, and is often associated with fœtal malformation. Three possible sources for such a discharge may be pointed out. Firstly, it may be a leakage from the amniotic sac (hydrorrhœa amnialis); secondly, it may come from an adventitious collection of fluid between the extra-placental chorion and amnion, resulting from imperfect fusion of these membranes; thirdly, it may come from the decidual space. In all probability the latter is the most common cause, and although it must be admitted that direct proof is wanting, decidual endometritis appears to offer the best explanation of the occurrence. A reference to Figs. 16 and 48 will recall the fact that in the lower part of the early gravid uterus there is a small cavity bounded on all sides by decidua, and termed the *decidual space*. In decidual endometritis a watery fluid such as that of hydrorrhœa may possibly be secreted, which accumulates in this space and is discharged from time to time through the cervix, when the amount becomes large. Normally the decidual space becomes obliterated at the end of the fourth month, but when the membranes are unhealthy their fusion may be delayed or prevented; the decidual space may then persist and the hydrorrhœa continue until term. The condition is not amenable to treatment of any kind, and is not of much clinical importance except when due to leakage of liquor amnii; it then

leads to premature labour attended by many of the difficulties arising from ante-partum rupture of the membranes.

Diseases of the Membranes and Placenta

Hydramnios (Synonym : Polyhydramnios).—This condition consists in the formation of an excess of liquor amnii. The amount of liquor amnii at term which may be regarded as normal varies considerably (p. 44) ; it is probable that only quantities exceeding 4 pints would be clinically recognisable as hydramnios. The fluid shows no abnormal characters, but it may attain the enormous bulk of 6 gallons.

The causation of hydramnios is by no means capable of simple explanation. It must be recollected that the condition is normal during the first eight weeks of gestation, and occurs in an exaggerated form in many cases of carneous mole. When occurring in the later months, it is occasionally associated with morbid maternal conditions such as dropsy from cardiac or hepatic disease, and more frequently with developmental anomalies of the fœtus. It is not clear, however, that these associations can be regarded as the cause of the hydramnios. Hydramnios is more common in multiparæ than primigravidæ.

It is quite possible that under normal conditions there may be both a formation and an absorption of liquor amnii, and hydramnios may therefore conceivably be brought about by deficient absorption as well as by excessive production. In some cases of hydramnios, extreme torsion of the cord, or thrombosis of the umbilical vein, has been found ; these conditions may lead to excessive transudation of fluid through the walls of the large vessels on the fœtal surface of the placenta. Whatever may be the precise mechanism of its production, certain considerations make it probable that hydramnios is usually due to a fœtal, not a maternal cause : (1) The mother is usually healthy ; (2) the fœtus frequently presents some deformity or abnormality of development, such as anencephaly, spinal bifida, talipes ; (3) it frequently occurs in uniovular (homologous) twin pregnancy, affecting only one amniotic sac ; (4) the liquor amnii is certainly an embryonic product when first formed in the ovum. In hydramnios associated with uniovular twins there is no doubt that the fœtal urine is the source of the fluid. The twins differ markedly in size, and the heart and kidneys of the larger twin are greatly hypertrophied ; the hydramnios affects the amniotic sac of the larger twin, that of the smaller twin containing a normal or a diminished quantity of fluid. The umbilical vessels of uniovular twins always anastomose freely in the single placenta, and if for some reason one twin obtains more than its fair share of the circulating blood, its heart and kidneys hypertrophy, with

the result that the secretion of urine is greatly increased and hydramnios follows.

As usually met with, hydramnios is a *chronic* condition which does not become clinically recognisable until the fourth or fifth month of pregnancy, and is slowly progressive. Its actual onset is, of course, earlier than this. Occasionally, however, it assumes an *acute* form, an enormous quantity of fluid being quickly formed. The acute form of hydramnios seldom occurs apart from uniovular twin pregnancy, and usually appears about the sixth month ; the uterus may become enormously distended within a few days. The symptoms of hydramnios are due to the size of the uterus ; when the enlargement has occurred rapidly, as in the acute form, the symptoms are correspondingly severe ; in the chronic form much greater toleration of the large uterus is met with. Slight degrees of hydramnios usually escape recognition, especially if associated with twin pregnancy. The abdominal enlargement is often extreme ; indeed, hydramnios may yield one of the largest abdominal swellings ever met with. Relatively to the size of the abdomen, the associated symptoms are slight, consisting chiefly of some embarrassment of respiration and cardiac action, especially in the recumbent position, so that the patient must sleep well propped up in bed. There may also be pain and slight anasarca of the lower extremities, and, of course, inability for physical exertion of all kinds. There is no special tendency to the occurrence of albuminuria. Labour usually comes on prematurely, with ante-partum rupture of the membranes, which brings immediate relief.

The physical signs yielded by the uterus in a case of well-marked hydramnios differ from those of the normal gravid uterus as follows : (1) Its size is disproportionately large and its contour more globular than the normal gravid uterus ; (2) a fluid thrill may be obtained in all directions ; (3) sometimes the presence of the fœtus cannot be recognised either by palpation or auscultation ; (4) in slighter degrees the fœtal head may be felt, or spontaneous movements detected. Signs of pregnancy will, however, be found in the active condition of the mammary glands (primigravidæ), the characteristic softening of the cervix, and a history of several months' amenorrhœa. These points should deter an observer from attributing the abdominal swelling to an ovarian cyst or to ascites. A large ovarian cyst may be occasionally associated with pregnancy ; the differential diagnosis from hydramnios is then more difficult, and will depend upon the recognition, in the former, of two distinct abdominal swellings together with the presumptive signs of pregnancy ; the physical signs of one of the abdominal swellings will correspond with those of the normal gravid uterus. The differential diagnosis from multiple pregnancy is more difficult,

especially as the two conditions may coexist; a correct diagnosis will be given by a radiogram. The possibility that there is also diabetes should always be remembered in cases of hydramnios.

There are no means known to us of controlling the production or absorption of liquor amnii, and this condition is therefore not amenable to treatment. If the pressure symptoms become severe, premature labour must be provoked, the method of choice being rupture of the membranes; this is more likely to be required in the acute than in the chronic form. The weaken-

Fig. 74.—Placenta Bipartita.

Note the bifurcation of the umbilical vessels at the point of insertion of the cord.

ing of the uterine muscle from over-distension leads to utèrine inertia and its attendant risks in labour (p. 407).

Oligo-Hydramnios.—In this condition the liquor amnii is deficient in amount, and there may be only a few ounces of fluid in the amniotic sac. Its causation is unknown, and it does not give rise to any maternal symptoms. The fœtus may show various deformities.

Oligo-hydramnios may give rise to certain of the less important fœtal deformities through the insufficient space which it affords for free exercise of the limbs. In this way club-foot, spinal curvature, wry neck, or ankylosis of joints may conceivably be brought about. It is, however, by means of *amniotic*

adhesions that still more important deformities are occasioned. These consist in the formation of intimate union between the amnion and some part of the skin of the fœtus ; the result is the production of surface deformities in the affected parts.

Occurring upon the scalp, encephalocele may result ; when surrounding a limb, strangulation followed by spontaneous amputation may occur ; sometimes the adhesion may strangu-

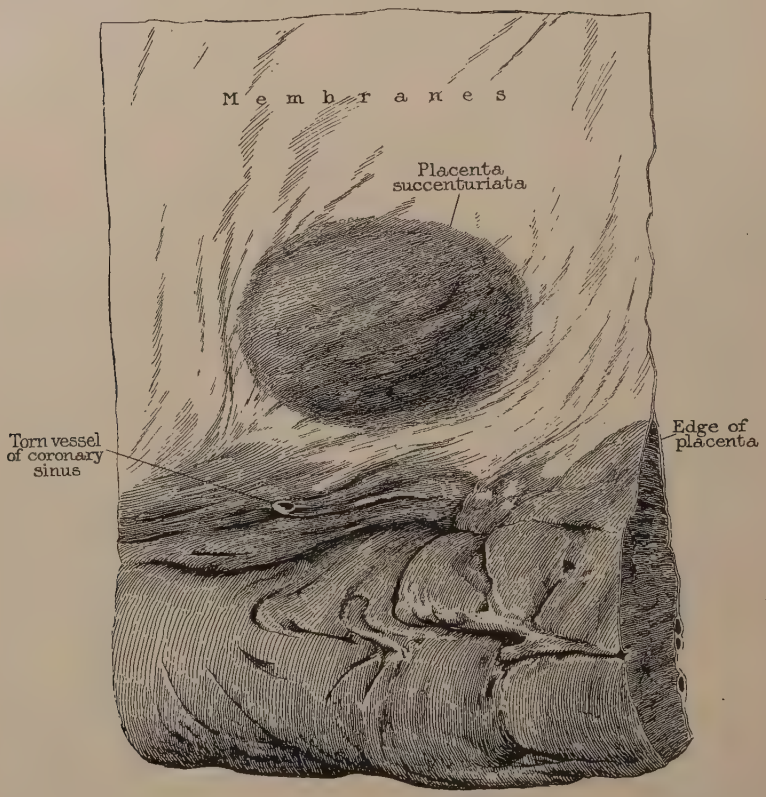


Fig. 75.—A Portion of Placenta and Membranes, showing a Small Placenta Succenturiata. (Charing Cross Hospital Museum.)

late the cord, causing the death of the fœtus. Amniotic adhesions, while usually associated with deficiency of liquor amnii, sometimes occur when the amount of fluid is normal or is excessive.

Diseases of the Placenta.—*Anomalies of Size and Shape.*—The placenta is sometimes divided unequally into lobes or segments, which are united by large vessels (umbilical) running in the membranes which connect them. There may be two lobes

(*placenta bipartita*) (Fig. 74), three lobes (*placenta tripartita*), or more than three (*placenta multiloba*). More important than these is another variety of divided placenta, called the *placenta succenturiata* (Figs. 59 and 75). In this form one or two small outlying portions of placenta, circular or oval in shape, are present ; they are connected with the main placenta by small vessels running in the membranes, and are very liable to be left

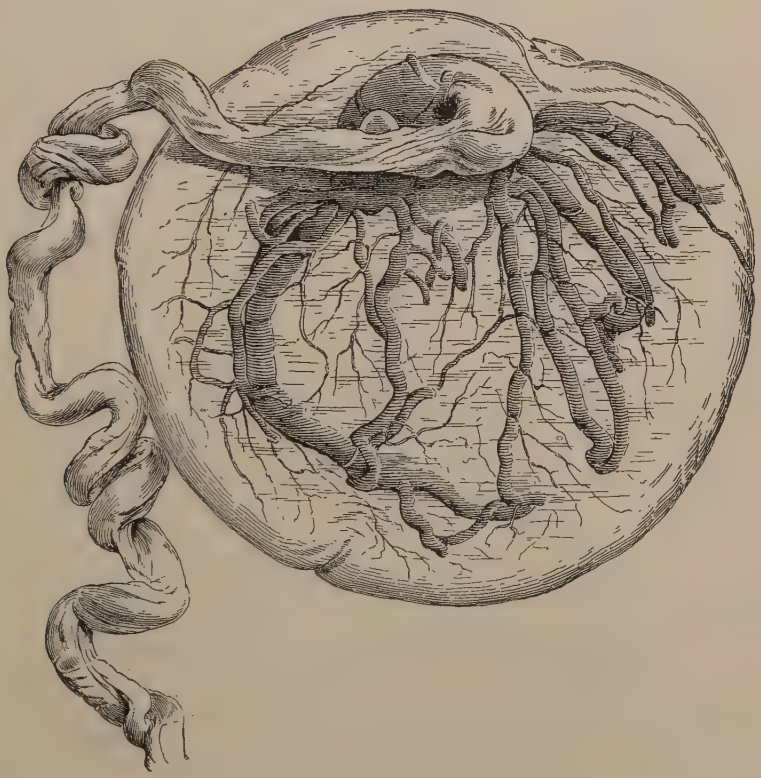


FIG. 76.—Battledore Placenta.

The umbilical cord is inserted close to the placental margin.

in the uterus after labour ; they may thus give rise to post-partum hæmorrhage, and (indirectly) in the puerperium to septic infection. Very rarely the placenta is formed over the whole area of the chorion, the usual differentiation into *chorion frondosum* and *chorion lævе* not taking place. This is known as the *placenta diffusa ;* it is the natural form in certain animals—*e.g.*, the sow and the mare.

Anomalies of the Umbilical Insertion.—The cord is usually attached to the placenta about its centre ; but the insertion may

be eccentric, lateral, or marginal, the latter being called the *battledore placenta* (Fig. 76). More important practically is the comparatively rare anomaly of the insertion of the cord into the membranes altogether outside the placental margin—the

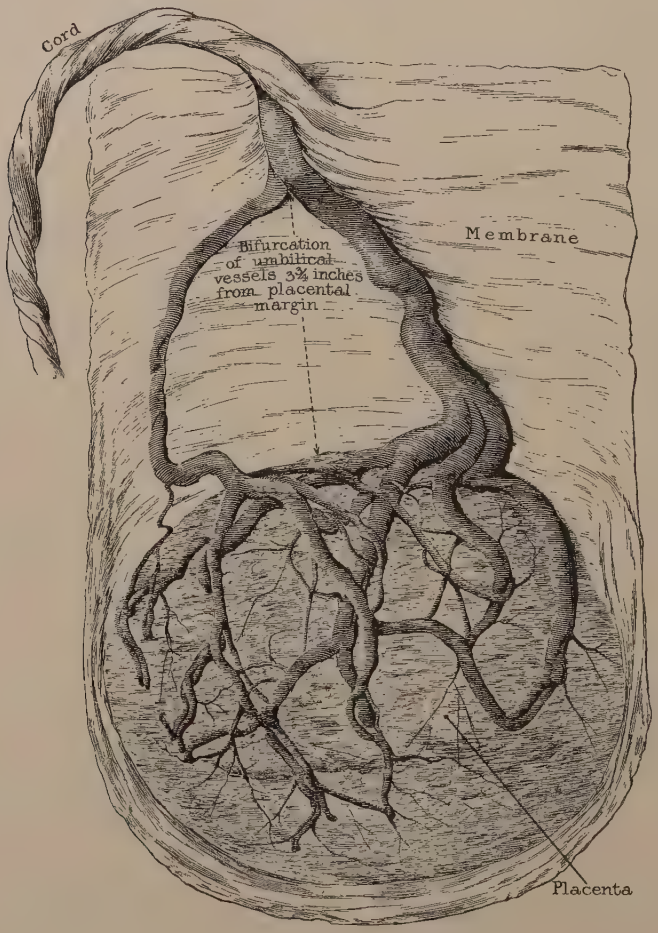
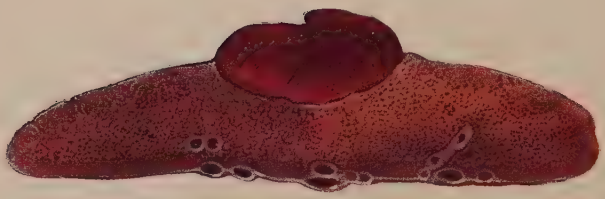


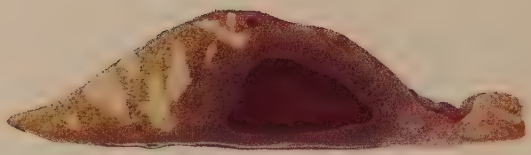
FIG. 77.—Velamentous Placenta.
The amnion has been stripped off.

velamentous placenta (Fig. 77). Very large vessels, constituting the primary divisions of the umbilical arteries and vein, then run beneath the amnion, from the point of insertion to the placental margin, and are liable to become injured during labour by compression, or by rupture of the membranes which enclose them. The latter accident is only liable to occur when these vessels are

PLATE V.



(1)



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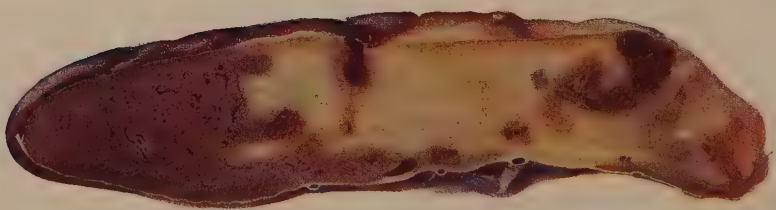


(3)

(1) Placenta with a Retro-placental Hæmatoma: from a case of Accidental Hæmorrhage.

(2) Placenta with an Intra-placental Hæmorrhage: from a case of Albuminuria of Pregnancy.

(3) Placenta with very Extensive White Infarction, occupying two-thirds of its volume.

To face p. 157.

situated in the position where the membranes rupture at the end of the second stage of labour. When in this situation the vessels are termed *vasa prævia*, and if they rupture extensively the fœtus may bleed to death.

Placental anomalies cannot, as a rule, be recognised until after delivery. An exception to this rule is the case of the velamentous insertion, which may be recognised during labour if the vessels chance to cross the lower pole of the ovum. A case of this kind has been recorded by Williamson, in which he delivered the child by Cæsarean section, in order to avoid the risks of fatal fœtal hæmorrhage when the membranes ruptured.

Pathological Infarction of the Placenta.—It has been already stated (p. 41) that, during the last two months of intra-uterine life, certain age-changes occur in the fœtal portion of the placenta which result in the formation of small solid areas, termed 'infarcts,' in the spongy placental substance. In connection with the albuminuria of pregnancy, and with chronic nephritis in pregnancy, changes of a similar nature, but much more extensive, and occurring earlier in gestation, are met with. These changes are probably important factors in the causation of the heavy fœtal mortality which attends these disorders. Very extensive 'infarction' affecting two-thirds of the placenta and leading to death of the fœtus early in labour is shown in Plate V., 3. In such cases recent hæmorrhages into the placental substance are also often found, and are probably due to rupture of vessels in the intra-placental decidua (Plate V., 2).

Degeneration of the Placenta.—Fatty, calcareous, and cystic degenerations are often met with in the placenta. Fatty and calcareous degenerations are usually combined, and are constantly found in infarcted areas; it is probably true that primary fatty degeneration does not exist in the placenta, and in no circumstances is it directly related to syphilis. Extensive calcareous degeneration of the uterine surface of the placenta is common when gestation has been unduly prolonged (post-maturity). Cystic degeneration results in the formation of small sub-amniotic cysts upon the fœtal surface of the placenta. They are frequently multiple; they are never large, and do not affect the functional activity of the organ. Hydatidiform degeneration has been already described.

Tubercle of the Placenta is very rare, but it has been shown to occur occasionally in women affected with acute general tuberculosis or advanced chronic phthisis. The tuberculous deposits may be found either in the decidua, upon the chorionic epithelium, or in the stroma of the villi; the last, which is the lesion most likely to produce congenital tuberculosis, is extremely rare. Caseation is frequently found in these deposits, and in cases of acute tuberculosis miliary deposits may be widespread in the fœtal portion of the placenta. It appears that there is

not much probability of placental infection except in advanced cases.

Solid Tumours of the Placenta are extremely rare, the greater number of those described being chorio-angiomata.

Hæmorrhage in the placenta—intra-placental hæmorrhage—is rare, and is seldom found apart from the toxæmic albuminuria of pregnancy; the hæmorrhages, which are often multiple, are due to rupture of vessels in the intra-placental decidua (Plate V., 2). Rupture of vessels in the retro-placental decidua, leading to retro-placental hæmatoma and 'accidental' ante-partum hæmorrhage, will be referred to in a later section (p. 445, Plate V., 1).

Œdema of the placenta is always associated with general

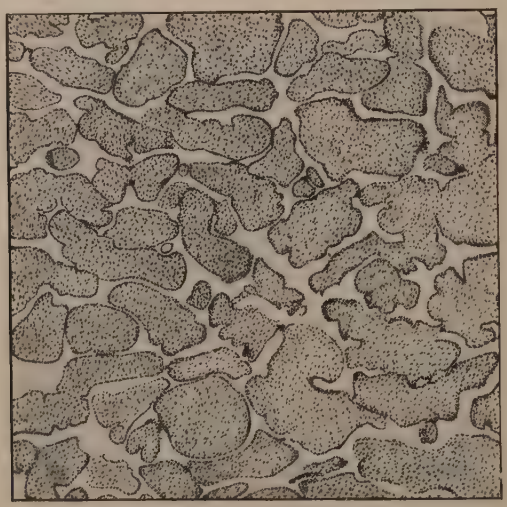


Fig. 78.—Syphilitic Placenta.

œdema of the fœtus—a rare variety of intra-uterine fœtal disease. These are the largest placentas known, and may actually weigh half as much as the fœtus; the villi are greatly enlarged from œdema of the stroma.

The Syphilitic Placenta.—Well-marked changes are found in the chorionic villi in cases of fœtal syphilis and form valuable diagnostic evidence of the disease. Recent work has shown that the naked eye appearance of the placenta reveals nothing of note. It is sometimes heavier than usual, but this is by no means constant and is not of the least value as evidence of syphilis. There is nothing characteristic in the form, colour or texture of the syphilitic placenta, and it seldom contains white infarcts. These points are emphasised because in the past it was supposed that the syphilitic placenta could be

recognised by a characteristic appearance and an unusual weight. The changes in the chorionic villi, shown in Fig. 78, are: (1) A uniform increase in the size of the villi, whereby they are crowded together and the intervillous spaces are correspondingly reduced in size; this change is due to an increase in the amount and density of the stroma, the collagen fibres being more numerous and the cells more abundant and closely packed. (2) A greatly diminished vascularity of the villi; the blood-vessels are usually absent in the terminal villi, and when present they are greatly reduced in number and size. These changes sometimes affect the whole placenta uniformly and sometimes only partially. The *spirochæta pallida* may be found in the placenta, but is extremely difficult to demonstrate.

Extra-Uterine (Ectopic) Gestation

It is now well established that a fertilised ovum may become implanted not only in the uterus, but in the Fallopian tube or in the ovary; in the two last-named positions the pregnancy is called extra-uterine or ectopic.

The possibility of the implantation of a fertilised ovum upon the peritoneum—*primary peritoneal pregnancy*—has been much discussed, but until the last year or two it cannot be said to have been satisfactorily demonstrated. Blair Bell now claims to have shown that it may occur in rodents, and consequently its occurrence in the human species cannot be regarded as impossible. Further, a case has been recorded by Gröné (Sweden) which he asserts to be one of the primary peritoneal pregnancy, the ovum having been implanted upon the peritoneum immediately behind the right round ligament. The case was submitted to operation, and as the patient recovered, a detailed histological examination of the uterus and Fallopian tubes was not made. While there can be no inherent impossibility about the occurrence of primary peritoneal pregnancy, its actual demonstration is beset with great difficulties, and there can be no question that if it occurs at all in women it is very much rarer than the other two varieties of ectopic pregnancy.

Ovarian Pregnancy

It is only within recent years that the occurrence of ovarian pregnancy has been satisfactorily proved, but the number of cases which can be accepted as reliable instances of the condition is now fairly large. There can be no doubt that it is very much less frequent than tubal pregnancy. In most cases the site of implantation appears to have been a Graafian follicle, which may be entered by spermatozoa through the site of rupture, or possibly by direct penetration of the wall.

The great majority of cases of ovarian pregnancy have terminated by rupture at an early period of gestation. Some,

however, have progressed up to or beyond the mid-term. A few cases of reputed ovarian pregnancy at term have been recorded, but in most instances the evidence of their exact nature is inconclusive.

Ovarian pregnancy cannot be distinguished by *clinical* methods from tubal pregnancy; questions of diagnosis and

FIG. 79.—Ovarian Pregnancy (Van Tussenbrock). The Ovum has developed in a Graafian Follicle; Rupture has occurred on the free surface of the Gestation-Sac.

treatment are therefore identical with those of the latter condition.

Tubal Pregnancy

Anatomy.—Tubal pregnancy gives rise to a series of well-marked changes in the uterus, and in the affected Fallopian tube; the former are uniform and constant, the latter vary with the location of the ovum. The *uterus* always shows a certain amount of enlargement, accompanied with softening of its walls and softening of the cervix; both are recognisable clinically, although the softening of the lips of the external os is not so well marked as in uterine pregnancy. The size of the uterus seldom exceeds that of two and a half months' gestation.

The endometrium is completely converted into a decidual membrane indistinguishable from the decidua vera of normal uterine pregnancy. In the affected *tube* the changes are mainly confined to the neighbourhood of the ovum, distant parts showing almost no changes recognisable with the naked eye. No true formation of a decidua occurs in the tube, although it has been demonstrated that clusters of large 'decidual' cells may be found here and there in the mucous membrane of both the affected and the unaffected tube. The portion of the tube which encloses the ovum is usually called the *gestation-sac*.

The fertilised ovum lodges most frequently in the *ampulla* of the tube, more rarely in the *isthmus*, and least frequently of all in the *interstitial* portion. It has been clearly shown that, when lodged in the tube, the fertilised ovum buries itself in the maternal tissues very much in the same manner as in uterine pregnancy. The mucous membrane undergoes no preparatory thickening, as does the endometrium ; penetration of the tissues is easy, and there appears to be no doubt that the ovum actually reaches the muscular coat and becomes completely imbedded in it. This arrangement compensates, to some extent, for the absence of a complete decidual investment, and renders the early lodgment of the ovum more secure. The formation of the embryo and of the embryonic coverings proceeds in the same manner as in uterine pregnancy. At the site of the growing ovum the tube undergoes rapid distension and assumes a somewhat oval form. The wall of the distended portion becomes considerably thinned ; this thinning is due in part to the absence of compensatory muscular hypertrophy, such as takes place in the gravid uterus, and in part to the eroding action of the chorion, which penetrates the tissues, and still further thins the wall. When the ovum lodges in the ampullary portion the abdominal ostium almost invariably becomes occluded before the end of the second month (eighth week) ; when the ovum lies in the isthmus or the interstitial portion the abdominal ostium does not close (Fig. 81).

From this account it is obvious that the ability of the Fallopian tube to continue to accommodate the growing ovum is by no means certain ; as a matter of fact it fails to do so except in extremely rare instances. It is, however, believed that genuine cases are on record of gestation continuing to term, or nearly to term, in an unruptured Fallopian tube. Failing this event, either the ovum is destroyed, or it escapes from its cramped surroundings and pursues its development under more favourable conditions. The ovum may be destroyed *in situ* by hæmorrhage which converts it into a *tubal mole ;* or it may be detached from its base and expelled either through the patent abdominal ostium (*tubal abortion*), or through a rent in the wall of the tube (*tubal rupture*). In some instances rupture occurs

without causing complete detachment of the ovum ; its existence is not then necessarily terminated, for development may proceed in the freer space thus gained for it.

The Tubal Mole.—The mode of formation of a tubal mole is

Fig. 80.—Section through a Gravid Fallopian Tube, illustrating the formation of a Tubal Mole (Whitridge Williams). *V*. Villi which have penetrated deeply into the wall of the tube, probably indicating the original implantation site ; *b.c.*, Blood-clot containing chorionic villi seen in section : in the centre of the mass is an irregular space representing the amniotic sac.

well shown in Fig. 80, which represents a transverse section through a gravid Fallopian tube at the site of implantation of the ovum. The lumen of the tube is occupied by an oval mass of blood-clot detached completely from the wall ; a cavity of irregular shape, representing the amniotic sac, is seen, placed

somewhat eccentrically in the midst of the blood-clot. The effect of the hæmorrhage has clearly been to break up the chorion, which at this early period is covered in all parts with villi ; many detached villi are seen in section in the blood-clot surrounding the ovum ; a few are seen still retaining their attachment to the ovum, others are seen to be buried in the tube wall and to be broken off entirely from the ovum. There is no appreciable thinning of the wall of the tube except at the right of the figure, where chorionic villi can be seen to have penetrated nearly as far as the peritoneal investment, thus breaking up the

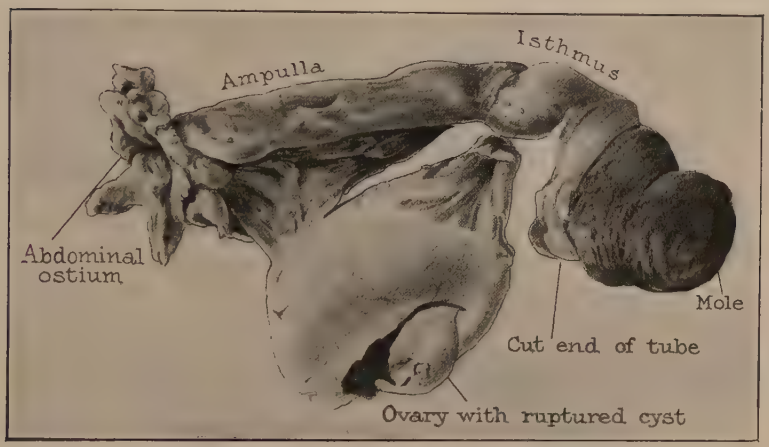


FIG. 81.—Tubal Pregnancy of Four to Five Weeks' Duration. Rupture has occurred in the isthmial portion of the tube, and a small mole has been extruded. The abdominal ostium is patent, and the ampullary portion shows little alteration.

muscular wall of the tube. This spot probably represents the pit in which the ovum was originally imbedded.

In operating on cases of tubal gestation a mole is frequently found among the blood effused into the peritoneal cavity by rupture or abortion ; it exactly resembles a lump of blood-clot, and may remain unnoticed unless carefully looked for. Small moles are nearly globular (Fig. 81) ; larger ones are oval in shape, heavier and firmer than simple clotted blood ; they often show remains of the amniotic sac on section, and on microscopic examination, after suitable hardening, they are found to contain chorionic villi imbedded in clotted blood.

Tubal abortion occurs frequently in ampullary pregnancy while the abdominal ostium remains patent—*i.e.*, during the first two months of gestation ; it is believed that it occurs almost as commonly as rupture in this variety of tubal pregnancy. In the isthmial and interstitial varieties, however,

rupture is much more frequent than abortion ; in the latter variety tubal abortion consists in the discharge of the ovum through the uterine ostium into the *uterine* cavity. An aborted tubal ovum, as a rule, has been previously converted into a mole, but this is not always the case. The first step in the process of tubal abortion is the separation of the ovum from its attachments. We have seen that as a rule the ovum develops within the tube wall, not in the lumen of the canal. At the site of implantation the lumen is distorted and compressed by the pressure of the growing ovum. At some point the inner tubal investment gives way and the gestation sac ruptures into the lumen of the tube ; this forms the first step in the occurrence of a tubal abortion. Berkeley and Bonney described this process as 'intra-tubal rupture' to distinguish it from 'tubal rupture,' in which the sac opens into the peritoneum or the broad ligament (*vide infra*).

FIG. 82.—Intra-Peritoneal Rupture of the Tube (diagrammatic ; after Giles). The chorion has been torn, but the amnion remains intact, the fœtus contained within it ; the placental portion of the chorion is uninjured. The fœtus may survive.

The actual process of abortion can sometimes be observed in operation specimens, which show the mole partly expelled through the dilated abdominal ostium. The main factor in its production is undoubtedly muscular contraction of the unaffected portions of the tube ; the process constitutes a miniature labour, consisting of a stage of dilatation followed by a stage of expulsion, which again is succeeded by a stage of retraction. The developmental unity of the uterus and Fallopian tubes no doubt accounts for this physiological analogy. The contractions are perhaps reflexly excited by hæmorrhage, causing sudden distension of the tube. The expulsion of the ovum may be complete or incomplete ; in the latter case the ovum is detained in the insufficiently dilated abdominal ostium, or a portion of it may remain attached to the original implantation site of the ovum, the bulk of which has been expelled. Here again the analogy with uterine abortion will be obvious. Tubal abortion may be

attended by severe internal bleeding, equal in severity to that caused by rupture ; its result as regards the ovum is invariably to destroy it. After the expulsion of the ovum the tube usually remains considerably distended with blood, but it is believed that it may rapidly retract and resume its normal shape and calibre, leaving no trace to the naked eye of having been recently gravid. It is impossible to distinguish tubal abortion from tubal rupture by clinical diagnosis.

Tubal Rupture.—In whatever part of the Fallopian tube the fertilised ovum may be lodged, there is a tendency to the occurrence of spontaneous rupture. In the isthmial and interstitial varieties rupture is apt to occur earlier than in the ampullary variety, owing to the fact that the latter is larger and more distensible than either of the former. Between the eighth and tenth week is the commonest time for rupture to occur, but it may be earlier or later than this. The conditions which predispose to rupture have been mentioned—viz., thinning of the tube wall by distension and the eroding action of the villi. In addition, there is probably a determining cause in most instances such as a sudden increase in size of the ovum from hæmorrhage, or slight increase in vascular tension from some muscular effort on the part of the patient. Occasionally the eroding action of the villi alone will determine spontaneous perforation of the wall of the tube. Occlusion of the abdominal ostium is not an essential factor in the causation of rupture, for this accident frequently occurs without it, even in the ampullary variety. Any part of the wall of the distended portion of the tube may burst.

The amount of internal bleeding may be so great as immediately to imperil life, and unless operated upon forthwith, the patient will die. In other cases the bleeding is more moderate.

The blood which is then slowly poured into the peritoneal cavity from the gravid tube tends to accumulate in the most dependent part of the peritoneal cavity—the pouch of Douglas. In some cases, probably when the bleeding is very slow, the effused blood does not reach the pouch of Douglas at all ; it becomes rapidly encysted by adhesive peritonitis and is detained in contact with the bleeding part, which may be the abdominal ostium, or a rent in some other part of the tube. An encysted collection of blood in the pelvic peritoneal cavity is called a *pelvic hæmatocele ;* when formed around the abdominal ostium it is distinguished as *peritubal,* when formed upon a rupture in the proximal part of the tube it is called *paratubal* (Handley). Around these encysted collections of blood a *false capsule* is rapidly formed by the deposition of layers of lymph externally, and beneath this by organisation of the superficial layers of the blood-clot. In this way a membrane one-eighth to one-quarter of an inch in thickness may be formed. In those rare instances

where intra-ligamentary rupture occurs, the blood is slowly poured out between the layers of the broad ligament, and this condition is distinguished as a *pelvic hæmatoma*. Hæmatocele of the pouch of Douglas is far commoner than either of the other varieties.

The results of rupture, in so far as the life of the *ovum* is concerned, depend to a great extent upon the position of the rent. If occurring upon the roof or sides of the tube, the rupture will involve the peritoneal covering, and the blood

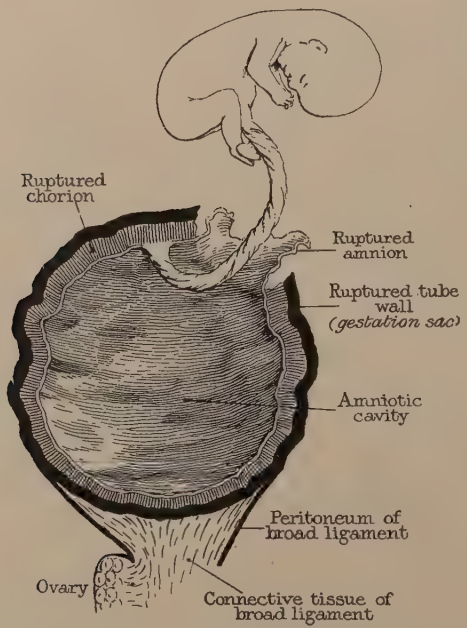


FIG. 83.—Intra-Peritoneal Rupture of the Tube (diagrammatic ; after Giles). The chorion and amnion have both been torn, and the fœtus has escaped from the gestation sac ; the placental portion of the chorion is injured. The fœtus will perish.

effused will therefore be poured out into the general peritoneal cavity, while the mole may be completely expelled through the rent (Fig. 83). If, on the other hand, the tear takes place in the floor of the tube, the peritoneal coat may escape, while the effused blood and the discharged ovum will make their way between the layers of the broad ligament, gradually separating them and burrowing in the connective tissue which this ligament contains (Figs. 84 and 85). This form of rupture is very uncommon and occurs mainly in cases of isthmial pregnancy, since the lower wall of this portion of the tube is less completely

invested by peritoneum than the ampulla. The former is known as *intra-peritoneal* rupture, the latter as *intra-ligamentary* or *extra-peritoneal* rupture. In both varieties the ovum is, as a rule, destroyed by previous hæmorrhage and converted into a mole. Apart from hæmorrhage, pregnancy almost invariably comes to an end (*a*) if the amnion is ruptured, or (*b*) if the placental portion of the chorion is lacerated or detached by the rupture (Figs. 83 and 85). Occasionally, however, the ovum may continue its development, and in such cases it is observed that the amnion has remained intact, and that the

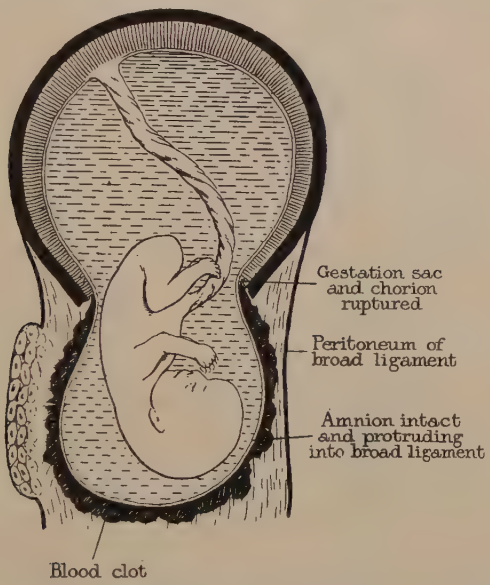

Gestation sac and chorion ruptured
Peritoneum of broad ligament
Amnion intact and protruding into broad ligament
Blood clot

FIG. 84.—Intra-Ligamentary Rupture of the Tube (diagrammatic; after Giles). The amnion and the placental portion of the chorion are uninjured. The fœtus may survive.

placental chorion was so situated as to escape injury from the rupture (Figs. 82 and 84). In intra-peritoneal rupture the placenta then grows out of the rent and becomes attached to the neighbouring peritoneal surfaces, while layers of lymph are deposited upon the exposed amnion from the surrounding peritoneum, forming a false membrane which constitutes a secondary gestation sac. This secondary sac becomes further strengthened by adhesion to the neighbouring peritoneal surfaces, including omentum, coils of intestine, and the abdominal parietes. The ovum is now known as a *secondary abdominal* (*intra-peritoneal*) *pregnancy*. Precisely similar results may follow extra-peritoneal rupture, and for the same reasons;

the condition is then described as *secondary abdominal* (*intra-ligamentary*) *pregnancy*. Of intra-ligamentary pregnancy two varieties are described. In the *anterior* variety the ovum in its growth raises the anterior peritoneal layer of the broad ligament, and strips the peritoneum from the abdominal wall. When fully developed, such a gestation sac may be incised and evacuated without entering the peritoneal cavity at all. In the *posterior* variety the posterior layer of the broad ligament and the floor of the pouch of Douglas are elevated by the growth of the fœtus, and the sac can then only be reached by a trans-

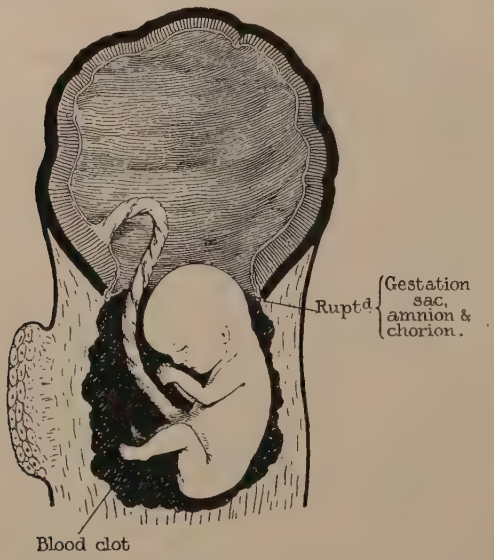


FIG. 85.—Intra-Ligamentary Rupture of the Tube (diagrammatic; after Giles). The chorion and amnion have both been torn, and the placental portion of the chorion is injured. The fœtus will perish. Bleeding is intra-ligamentary.

peritoneal operation. Both intra-peritoneal and intra-ligamentary pregnancy may continue to term; the patient then usually passes through a 'false labour,' and the fœtus perishes. The occurrence of this false labour is a physiological point of great interest and importance, but we have no information as to its causation, or the mode in which it leads to the death of the fœtus. False labour is attended with severe abdominal pain, which is mistaken by the patient for labour, but there is no clinical evidence that uterine contractions play any part in its production. Intra-ligamentary pregnancy may undergo *secondary rupture* into the peritoneal cavity; even then the

ovum is not in all cases destroyed, but may continue as an intra-peritoneal pregnancy.

In the intra-peritoneal form of secondary abdominal pregnancy the gestation-sac consists of a membrane which is largely inflammatory in origin, and is composed of layers of lymph deposited upon the amnion, in which organisation has proceeded to a variable extent. This membrane becomes closely adherent internally to the amnion, externally to the abdominal walls, and to the viscera, which structures support it and add to its strength. A great deal of the placental blood supply is obtained from adherent omentum and mesentery.

In the intra-ligamentary form the gestation-sac consists of the tissues composing the broad ligament, which are progressively expanded as the fœtus grows. The process causes great changes in the anatomical relations of the parts. Thus the peritoneum is raised from the pelvis, and stripped off the anterior abdominal wall, so that the reflection which corresponds to the floor of the utero-vesical pouch may exceed the height of the umbilicus (anterior variety), or the level of the pouch of Douglas is raised, and the mesentery of the colon on either side may be opened up and stretched over the gestation-sac. An incidental result of these changes is that in such cases the sac may be opened by an abdominal incision without traversing the peritoneal cavity at all (anterior variety).

Many cases are on record, both in ancient and in modern times, in which an extra-uterine fœtus has been retained within the abdominal cavity for many years after its death. In some of these cases the gestation sac has become infected from the bowel or the uterus, and suppuration has occurred, resulting in the formation of fistulous communications with the exterior, or with the neighbouring hollow viscera—large intestine, bladder, and vagina. Through these fistulæ fœtal bones are from time to time discharged. When, however, the sac remains free from infection the body of the fœtus shrinks by absorption of its fluid constituents, and in or upon the dried tissues lime-salts become freely deposited, converting it into a *lithopœdion*. In this condition it may be retained for many years with little disturbance to the patient.

Clinical Features and Treatment of Tubal Pregnancy

It is unnecessary to consider the details of diagnosis and treatment in a text-book of midwifery; they are fully dealt with in text-books of gynæcology, and will be better understood by the student in connection with that subject.

II.—DISORDERS ASSOCIATED WITH PREGNANCY

Acute Infectious Fevers.—Pregnancy forms a serious complication of the acute exanthemata, not because the severity of

the disease is thereby increased, but on account of the high percentage of cases in which abortion or premature labour occurs. This risk is common to all, but appears to be greatest in small-pox, scarlet fever and enteric fever. Abortion is probably almost always due to transmission of the disease, *i.e.*, by hæmatogenous infection of the ovum. The manner in which high temperature causes abortion is doubtful, and it appears that the severity of the disease is the most important factor. It has now been shown that nearly all the exanthemata may be transmitted to the fœtus. In enteric fever it has been shown that the bacillus may be demonstrated in the fœtal organs, that Widal's reaction may be obtained from the fœtal blood, and that ulceration of Peyer's patches may also be found in the fœtal intestine.

Inasmuch as pregnancy does not influence the course of the disease, obstetric interference is not as a rule indicated. In enteric fever, induction of abortion would probably be a useful prophylactic measure, if undertaken early in the course of the disease, for if abortion should occur in the critical third or fourth weeks the maternal prognosis would be considerably prejudiced.

Influenza, even in the acute form, is not unfavourably influenced by pregnancy unless pulmonary complications, such as pneumonia or empyema, supervene. Septic pneumonia with pregnancy is almost always fatal to the mother, but not necessarily to the fœtus, which may survive even when born prematurely. Empyema is a much less serious complication from the obstetric point of view than pneumonia.

Chronic Infections (Tubercle, Syphilis, and Gonorrhœa).—*Phthisis* in women does not unfavourably affect fertility, nor does it unfavourably influence the course of pregnancy ; usually the resulting children are well developed and show no sign of tuberculous disease when born. During pregnancy phthisical women may appear to improve in health, but in the puerperium the tuberculous disease usually advances more rapidly. In a certain number of cases of acute miliary tuberculosis or advanced pulmonary phthisis, the transmission of tubercle bacilli from the mother to the fœtus has been demonstrated, but this occurrence is rare. Only exceptionally does phthisis form an indication for the artificial termination of pregnancy. When pregnancy is far advanced induction of premature labour offers no advantages, as its effect on the patient is no different from labour at term. When, on the other hand, pulmonary tuberculosis is diagnosed, or first makes its appearance, during the early months of pregnancy, the induction of abortion is indicated in order that the patient may place herself under the best possible conditions for curative treatment.

Syphilis.—Since the discovery of the *Spirochæta pallida* and

of the Wassermann reaction our knowledge of the influence of syphilis on pregnancy has become much more precise. We know now that syphilis ranks as the most frequent cause of ante-natal death of the viable fœtus (after the twenty-eighth week of pregnancy); in about one-third of all macerated fœtuses of viable age the spirochæte can be demonstrated in the fœtal tissues, or other signs of fœtal syphilis, or of maternal or placental syphilis, can be found. On the other hand, it has become apparent that syphilis as a cause of abortion has been grossly exaggerated; this we know because (1) positive Wassermann reactions are not unusually frequent in women who abort; (2) the spirochæte cannot be demonstrated in any part of the ovum in cases of abortion; and (3) the reproductive histories of syphilitic women do not often reveal an unusually high percentage of abortions. Though not a common cause of abortion, syphilis appears, however, to be one of the causes of habitual or repeated early abortion. Infection of the fœtus with syphilis has one of three results: (1) The fœtus perishes *in utero* at or shortly after the twenty-eighth week of pregnancy; (2) an apparently healthy child is born who develops signs of the disease after a few weeks or later in life; (3) a living child is born with obvious signs of congenital syphilis. Which of these occurs depends largely on whether maternal infection has occurred before pregnancy, at the time of conception, or during the course of pregnancy. If maternal infection occurs at the time of conception or in the early part of pregnancy, the fœtus usually dies *in utero*. If infection occurs during the last three months of pregnancy, the fœtus often escapes trans-placental infection, but may become inoculated by the infective maternal tissues during birth through an abrasion on the scalp or elsewhere. If the mother has acquired syphilis before pregnancy the effect on the fœtus varies according to the stage of the maternal disease; if the interval between infection and pregnancy is a short one and the disease is in the active stage, the fœtus usually dies *in utero;* but if the interval is a long one, and the disease has reached the latent stage, a living child is usually born, who develops signs of congenital syphilis within a few weeks or later in life.

When a woman is infected during pregnancy, owing to the vascularity of the vulva the primary sore may assume very large proportions. But this is most unusual, and the remarkable thing about syphilis in pregnant women is that the disease may run an extremely mild course; the secondary lesions may be so mild as to escape notice or may be absent altogether, and the woman may not have been aware of a primary sore. In women who give birth to syphilitic fœtuses or children, it is unusual to notice clinical signs or to obtain a history of the disease. But *such women are always syphilitic*, and the proof is

found : (1) In the Wassermann reaction ; (2) in the eventual appearance, late in life, of late secondary lesions such as gummata and disease of the central nervous system ; (3) in the clinical fact that such a woman may suckle her child without developing any sign of the disease (because, of course, she is already syphilitic), whereas the same child is capable of infecting others : this phenomenon has long been known as ' Colles's law of immunity ' ; (4) in the clinical observation that such women may continue to give birth to syphilitic infants when married to men who have never contracted the disease.

Because evidence of the disease was so commonly absent in women who gave birth to syphilitic children, it was at one time believed that a woman could give birth to such children without herself having contracted the disease. To account for this, *paternal infection of the ovum* was invoked. When the Wassermann reaction came and proved the presence of the disease in the mother, it was supposed the infection must have reached her from the fœtus ; to this supposed phenomenon the name of *conceptional syphilis* was given. It is unnecessary to believe either in ' paternal infection of the ovum ' or in ' conceptional syphilis.' The mother is always infected in the usual way, but suffers from a very mild form of the disease. Without syphilis of the mother there cannot be syphilis of the fœtus ; fœtal infection is always *trans-placental.*

Anti-syphilitic treatment during pregnancy by salvarsan and mercury, if begun not later than the fifth month and continued during pregnancy, is almost certain to eliminate infection of the fœtus ; the salts of arsenic and mercury are transmitted through the placenta. Since the mother always has the disease she may suckle her syphilitic infant with impunity, but it should, of course, never be suckled by a wet-nurse. The fertility of women is not diminished by syphilis. The pathology of fœtal syphilis will be found on p. 575, and of placental syphilis on p. 158.

Gonorrhœa.—When this disease is contracted during pregnancy it is apt to give rise to a very *acute* form of vulvo-vaginitis, associated with extensive redness and œdema of the skin surfaces, and the formation of diphtheroid patches upon the mucous membranes. The acute form almost necessarily ends in abortion and is accompanied by the gravest risk of upward spread of the infection to the uterus, the Fallopian tubes and the pelvic peritoneum. Acute decidual endometritis, gonorrhœal peritonitis, or an acute abscess of the tubes will then result, all these conditions being of the most serious nature.

Chronic gonorrhœal infection is most commonly met with in the form of endocervicitis or vulvo-vaginitis accompanied by a purulent discharge. The former condition is usually associated with sterility, but it is not an absolute bar to conception.

Vulvo-vaginitis, on the other hand, has little influence either upon conception or on the course of pregnancy. In many instances impregnation and infection occur at the same time, but so long as the disease is not acute, abortion is uncommon, and it is probably quite exceptional for the uterus to be invaded by the organisms. After abortion or labour, however, in all cases there is the risk that the disease may spread to the Fallopian tubes, ovaries, and pelvic peritoneum with the most serious or even fatal consequences. During labour gonorrhœal vaginitis, whether acute or chronic, entails serious risks of infection of the eyes or mouth of the fœtus. Gonorrhœal discharges at all stages of pregnancy accordingly require careful local treatment by measures the details of which are described in text-books of gynæcology. It must also be remembered that gonorrhœal discharges are infectious at all stages, and even when the specific organism has disappeared other pathogenic bacteria may be present ; the greatest care must, therefore, be taken to prevent the transmission of infection to other patients.

Malaria.—This disease is not often seen in this country with pregnancy. In countries where malaria is endemic it is however of frequent occurrence, and experience shows that the disease exerts little, if any, unfavourable influence upon pregnancy. Attacks of malaria are apt to be more frequent and severe than usual when pregnancy has occurred, and recrudescence of the disease is not infrequent in cases in which it has become quiescent. Malaria may be treated freely with quinine, for the oxytocic properties of the drug are said to be very feeble in the subjects of this disease, a result which may probably be referred to tolerance established by previous administration of large doses.

Diseases of the Heart and Circulatory System.—Chronic *valvular disease* of the heart is not infrequently met with in pregnant women. In a series of cases collated by Fellner, in about 70 per cent. the mitral valve was the one affected, mitral insufficiency, either alone or combined with stenosis, being much commoner than simple stenosis, which is but rarely met with in pregnancy. Lesions of both the aortic and the mitral valves may also be met with, but simple aortic lesions are rare in women.

Of valvular lesions the most serious of all to the pregnant woman is mitral stenosis. The gravity of valvular disease complicating pregnancy has been greatly overestimated, and one can only suppose that the statistics that are usually quoted are made up almost entirely of cases in which compensation had failed, and do not take into account the slight and moderately severe cases which occur relatively frequently in a large series of deliveries. It would appear in reality that not much more

than 2 per cent. of cases end fatally, and that in the majority the condition is so mild as to escape attention unless especially examined for. The view of valvular disease which is now generally held by physicians is that the particular valve affected and the variety of the lesion are relatively unimportant in comparison with the condition of the cardiac musculature. All valvular lesions may be completely compensated, so that no ill-effects are apparent, if the cardiac muscle is able to supply the increased force required to overcome the obstacle offered by the damaged valve. When from overstrain, or from general ill-health, the nutrition of the cardiac muscle is unfavourably affected, or when from intercurrent disease, such as bronchitis, the work thrown upon the right heart is suddenly increased, the cardiac muscle fails to accomplish the work required to maintain the equilibrium of the circulation, and the state of compensation breaks down. It is to this failure of the heart muscle that the so-called symptoms of valvular disease are in reality due. It is therefore of the greatest importance that in pregnant women attention should be directed more to the manner in which the heart does its work than to the murmurs which may be audible. The signs of failure of compensation and their significance must be clearly understood.

The earliest sign of failing compensation is increased rapidity of the pulse, which also becomes irregular both in rhythm and in force. Fatigue and breathlessness, with rapid rise of the pulse rate on any exertion, are also characteristic. Later on come anasarca, beginning in the feet, scanty and albuminous urine, bronchitis, hydropleura or hydropericardium, and, it may be, signs of auricular fibrillation or complete ' heart block.'

Compensation is least likely to break down in the early months of pregnancy, but there are serious risks in the later months, during labour, and in the early days of the puerperium. The pains of the second stage of labour are, of course, particularly serious from the great strain that is thrown upon the heart. After labour it is the sudden fall in blood pressure following evacuation of the uterus which is most to be feared.

So long as compensation is maintained the valvular lesion is unimportant, and many women with mitral incompetence, for example, have passed without danger through a number of labours. And even when early symptoms appear, care and proper management, as a rule, will enable the case to be carried through without serious danger arising. The greatest care is always required to avoid overstrain and maintain the general health, and if this is done the presence of the murmur is unimportant. Owing to the supposed gravity of mitral stenosis in pregnancy, some observers have gone so far as to advise women suffering from this lesion not to incur the risk of pregnancy. This advice is certainly unnecessary so far as

a first pregnancy is concerned. The case of a woman in whom failure of compensation occurred in a previous pregnancy is, however, different. There is no doubt that failure of compensation inflicts permanent injury upon the cardiac muscle, and reduces the patient's expectation of life. In such a case pregnancy should, if possible, be avoided, and if it should occur it would be right to terminate it at once, for the chance of another failue of compensation occurring would be great, and its probable results extremely serious.

Management.—Pregnant women with heart disease should be warned of the great importance of avoiding fatigue and strong muscular exertion, and should be directed to take an hour or two each day for complete rest lying down. Irregular hæmorrhages during the early months are not uncommon, and should be treated by putting the patient to bed. If considerable in amount abortion is likely to occur, no matter what is done, and the tendency to abortion or premature labour in heart disease is well recognised.

Treatment is directed, in the first place, to restoring the heart's action, not to interfering with pregnancy. Signs of failure of compensation should be treated by absolute rest in bed, simple diuretic and aperient medicines, and an easily digestible diet. Cardiac tonics, such as digitalis, in small doses are also useful. If serious symptoms, such as dyspnœa and cyanosis, suddenly supervene, venesection to the extent of 10 to 12 ounces of blood will afford immediate relief, and should be followed by digitalis *in full doses*. Accumulation of fluid in the chest may occur ; when in large amount it adds greatly to the difficulties of the heart, and should be treated by tapping.

It must be understood that obstetric interference is rarely necessary in cases of heart disease, and it is often surprising to watch the great improvement which takes place, even when compensation has broken down, under suitable treatment. Failure of compensation rarely occurs in *early* pregnancy ; usually it is in the later months, and then the question of artificially terminating pregnancy should not be considered unless, after a fair trial, the restorative treatment proves unsuccessful in disposing of the more dangerous symptoms. The pains of labour, especially those of the second stage, throw a great amount of additional strain upon the heart, and anything possible should be done to expedite it. Ether may be given freely in the second stage, and labour terminated with forceps. The more serious cases might be suitably delivered under spinal anæsthesia, if pulmonary conditions are present which increase the risks of general anæsthesia ; Cæsarean section, with sterilisation of the patient if thought advisable, can be thus carried out, and in the most serious cases this method of delivery is probably the best in the interests of the mother.

A woman who has once survived a failure of compensation during one pregnancy should be advised not to incur the risk of another ; and should pregnancy occur, it would be right to terminate it at once, for, as has been already said, a breakdown of compensation inflicts permanent injury upon the heart.

Varices in the lower extremities and labia majora are apt to become greatly aggravated by pregnancy, giving rise to pain and inability to walk. Vulval varices sometimes rupture from traumatism, leading to profuse hæmorrhage, which has been known to prove fatal in the absence of proper surgical aid.

Renal Diseases.—The influence of chronic nephritis upon pregnancy has already been referred to when considering the subject of albuminuria. To distinguish between this condition and the transient renal changes characteristic of the ' albuminuria of pregnancy ' may be somewhat difficult when the existence of chronic nephritis has been unsuspected before conception. Of great assistance is a history of scarlet fever or diphtheria with subsequent illness, or of albuminuria or eclampsia with a former pregnancy. In the following points chronic nephritis with pregnancy will be found to differ from the albuminuria of pregnancy (see p. 104) :

(1) Albuminuria and œdema appear much earlier.

(2) Œdema is likely to affect earlier the face and upper extremities.

(3) Characteristic changes may be found in the arteries, the heart, and the retina (exudative retinitis may, however, occur in the albuminuria of pregnancy).

(4) Intercurrent attacks of acute nephritis may occur.

Renal efficiency tests are not of much assistance in distinguishing the two conditions. The response to the urea concentration test is usually lower in chronic nephritis. Low diastatic values of the urine are typically associated with chronic nephritis, whereas in the toxæmias of pregnancy the diastatic value is within normal limits. Renal casts are present equally in both conditions.

In general terms it may be said that, on the one hand, the effect of pregnancy usually is to aggravate the renal disease ; on the other, the disease usually causes the pregnancy to terminate prematurely, tends to destroy the fœtus by inducing placental degeneration, and may cause the death of the mother from uræmia. Convulsions which ensue under these circumstances must be regarded as mainly uræmic in origin. The fœtal mortality in chronic nephritis is very high indeed.

From these considerations it will be apparent that pregnancy in the subjects of chronic nephritis involves grave risks. A patient who has survived an attack of uræmia in a previous pregnancy should not be allowed to incur the risks again ; and if conception does take place, abortion should be induced with-

out delay. In a primigravida, or if previous pregnancy has not been attended with serious complications, palliative treatment may be adopted ; but the chances of the patient bearing a living child are by no means good. The occurrence of an intercurrent acute attack of nephritis almost always ends in abortion.

It will be obvious that pregnancy with chronic nephritis calls for the most careful observation of the patient's condition. Regular weekly examination of the urine should be made, and the functional efficiency of the kidney should be tested at suitable intervals. Restriction of protein elements in the diet is desirable from the beginning, and this of itself will result in a comparatively low output of urea. Regular and frequent estimation is accordingly the only way in which a diminution due to toxæmia can be recognised. Irregularities of diet, fatigue, and chill are especially to be avoided, and it must be recollected that the premonitory symptoms of eclampsia (see p. 110) include such inconsiderable symptoms as headache, functional disturbances of vision, and complaints of 'indigestion.' During the later months of pregnancy the condition of the fœtus should be watched ; if the fœtus dies it is desirable to induce labour without delay, for the risks attending the condition are not greatly diminished until the uterus has been evacuated.

Bacillus Coli Infection of the Urinary Tract : Pyelitis of Pregnancy.—It is only within recent years that the occurrence of an acute form of pyelitis, or pyelonephritis, during pregnancy has been recognised. It has however been established that in almost all cases the disease results from *bacillus coli* infection, usually as a pure infection, but sometimes mixed, pyogenic organisms being also present. Further, although the renal pelvis is the position in which the most marked lesions occur, the kidney substance, the ureter, and, though more rarely, the bladder, also may be infected. It is accordingly better to name the condition 'Bacillus Coli Infection of the Urinary Tract.'

The condition seldom occurs earlier in pregnancy than the fourth month ; occasionally an acute attack of great severity occurs in the puerperium, when care will be required to distinguish it from acute septicæmia (p. 513). It may assume either an acute or a chronic form, and as a rule there have been no symptoms of cystitis or of renal disease previous to the pregnancy.

In the *acute* form the patient is suddenly seized with acute abdominal pain, sometimes attended with shivering, and leading after a few hours to abdominal distension and sometimes to vomiting. The pain, diffused at first, usually settles down to the right side, but in a small proportion of cases the left is

the affected side. The bowels are usually constipated and the tongue furred. The kidney, when palpable, is tender and may be enlarged ; often there is well-marked rigidity of the rectus muscle over it, and so much tenderness that detailed palpation is impracticable. Sometimes the pain on pressure is felt chiefly in the costo-vertebral angle. The gravid uterus usually shows no abnormality, but tenderness, with thickening of the terminal portion of the ureter (usually the right), may be detected *per vaginam* on deep palpation at the sides of the cervix anteriorly. The temperature may be raised to 103° to 104° F., and the fever continues irregularly for some days unless controlled by treatment. Sometimes rigors occur, and the general condition of the patient is so much affected as to give rise to anxiety.

On examination of a catheter specimen of the urine it will usually be found distinctly acid ; less often it has been observed to be neutral or alkaline. It is turbid and contains flocculent *débris*. In the great majority of cases culture methods yield a pure *bacillus coli ;* sometimes pyogenic organisms are also present. There are no renal casts, but the deposit may contain a little blood, and there is always a good deal of pus, shed epithelial cells, and epithelial *débris* from the urinary passages. The quantity of urine is usually small, and there is no offensive odour. A trace of albumen is always found. In many cases the onset is less acute than this, but fever and severe pain in the abdomen or flank are invariably met with.

In the *chronic* form the symptoms are, of course, less characteristic. There is often slight irregular fever, but this is not invariable, and the patient complains of backache and sometimes of persistent irritability of the bladder. On palpation the kidney is sensitive and may be enlarged.

The right kidney shows a marked predisposition to this disease, but not to the extent that was at one time believed. Out of 129 cases collated by Albeck and Lenharz, in 67 the right kidney alone was affected, in 26 the left kidney alone, and in 36 both right and left were affected. It has been shown that the ureter may be dilated, at any rate in its abdominal part, upon the affected side. It is generally agreed that this dilatation does not affect the pelvic portion of the ureter, *i.e.*, that it is only found in the part which lies above the pelvic brim. It will be recollected that such ureteral dilatation is commonly found in autopsies on pregnant women who have died from various causes.

Acute catarrhal inflammation is found in the renal pelvis and ureter ; sometimes, but this is very rare, there is also cystitis. From obstruction to the ureter a pyonephrosis may supervene.

Causation.—This disease is in all cases due to infection of the urinary tract by the *bacillus coli*. When other organisms are

also found in the urine secondary infection has probably occurred. The manner in which the *bacillus coli* obtains access is at present unsettled. There are three possible routes to be considered. The first and most obvious is an ascending infection *per urethram;* as Williamson has pointed out, this may occur either by direct infection of stagnant urine above the ureteral block, or by the peri-ureteral lymphatics. By this route the bladder would first be infected, but clinically the special symptoms of cystitis are seldom observed in the early stages. The second is by the circulation, the organisms passing through the kidney and attacking the mucous membrane of the renal pelvis. The third is a direct infection from the bowel, the organisms passing from the colon through the peri-ureteral cellular tissue to gain access to the ureter, or possibly to the kidney. Even if the route by which the infection travels were known, we do not know what causes the *bacillus coli* to assume pathogenic activity during pregnancy.

A mechanical explanation has been suggested, viz., that pressure exerted by the gravid uterus upon the ureter at the pelvic brim may predispose to the occurrence of infection by leading to retention of urine above the line of pressure. The infection may, however, occur in the early months before the uterus is large enough to compress the ureter; and further, other conditions, such as uterine tumours, likely to produce mechanical obstruction of the ureter do not lead to urinary infection.

Diagnosis.—An acute attack of pyelitis, with its sudden febrile onset and its preponderance on the right side, must be carefully distinguished from acute appendicitis, which it resembles in many respects. Acute cholecystitis may also give rise to a similar clinical picture. Ultimately the diagnosis depends upon the condition of the urine, and the importance of carefully examining a catheter specimen in cases of doubt must be borne in mind. The urine is acid, more or less turbid, and contains a microscopic amount of pus; culture is required to demonstrate the organisms.

Treatment.—In an acute case the patient should be kept in bed, the diet restricted to fluids, chiefly milk, and large doses of an alkaline diuretic, such as citrate or acetate of potash, administered with the object of increasing the amount of the urine and making it strongly alkaline. It appears that an acid urine forms a better culture medium for the *bacillus coli* than an alkaline urine. The acute symptoms usually subside in a few days if a free flow of urine can be maintained, and it is probable that much of the initial severity of the attack results from dilatation of the renal pelvis and ureter. The bowels must be freely moved every day. The urinary infection can be directly attacked in two other ways, viz., by urinary antiseptics.

and by autogenous vaccines. The most powerful urinary antiseptic is the substance known as urotropin, a synthetic compound prepared from formaldehyde (formalin). This body is efficient only in an acid medium, and it is desirable to administer with it a salt which tends to increase the acidity of the urine, such as acid sodium phosphate. Ten grains of urotropin with twenty grains of acid sodium phosphate may be given three times a day. It is clear that this line of treatment cannot be combined with the administration of alkaline diuretics, and urinary antiseptics should be withheld until the acute symptoms have subsided under the influence of alkaline drugs. The results obtained with vaccines are unreliable, and this treatment is rarely required. Medicinal measures usually suffice to relieve the symptoms, but the specific organism often persists in the urine after the symptoms have all disappeared.

If medical treatment fails to relieve the condition, two other methods of treatment are available, viz., *induction of labour* and *nephrotomy*. The results of inducing labour have been almost invariably favourable, and this clinical fact lends support to the theory of mechanical obstruction of the ureter already referred to. Nephrotomy should be reserved for cases in which all other measures have failed, or in which the urgency of the symptoms suggests the possibility of pyonephrosis, or of infection of the renal cortex.

Catheterisation of the ureter, either alone or with irrigation of the renal pelvis, is sometimes practised.

Diabetes and Pregnancy.—Though the occurrence of sugar in the urine during pregnancy is not uncommon, true diabetes is rare. It must be recollected that this disease is characterised by great polyuria, thirst, and wasting, as well as by the presence of glucose in large amount in the urine. In pregnancy sugar may occur in the urine as glucose or as lactose. The latter is commonly present during nursing, and often in traces in pregnancy ; it is of no clinical significance. Glucose may occur either as *alimentary glycosuria* or as *diabetes ;* in the former the sugar completely disappears when the carbohydrates are rigidly cut down, and it is not attended by the other symptoms just mentioned.

It follows that the presence of traces of sugar in the urine of a pregnant woman need give rise to no concern. Both glucose and lactose reduce copper sulphate and thus react to Fehling's test ; but they can be distinguished by the polarimeter or by the fermentation test. Whenever glucose is detected in more than traces, quantitative estimation should be made of the sugar in the urine and the amount of blood-sugar should be estimated, in order that a correct diagnosis may be made. If true diabetes is revealed, the appropriate treatment is begun without delay. In *true diabetes* the prognosis is mainly influenced by

the severity of the disease ; in moderate cases pregnancy and labour may end favourably both to mother and child ; in severe cases there is a special risk of diabetic coma in the later months or during labour. In 66 cases collected by Whitridge Williams (in the pre-insulin days), 27 per cent. of the mothers died at the time of labour or within two weeks, while an additional 23 per cent. died during the following two years. The gravity of pregnancy as a complication of diabetes has almost vanished since the introduction of *insulin*, and with its aid a woman may pass through pregnancy and labour with comparative impunity. Nevertheless, in spite of carefully regulated insulin treatment, the influence of pregnancy on the course of the disease is not altogether favourable. Hydramnios is said to be frequently associated with diabetes, the amniotic fluid containing sugar.

Diseases of the Nervous System.—*Neuritis*, supposed to be of toxæmic origin, sometimes occurs during pregnancy; it may affect a single nerve or may be multiple. Severe pain, limited to the distribution of the affected nerve, is the prominent symptom. It disappears rapidly after labour.

Chorea is not infrequently met with during pregnancy ; it is commoner in the first than in a subsequent pregnancy. In about two-thirds of the cases there is a previous history of rheumatism, or of chorea and rheumatism combined. By many obstetric writers it is regarded as a toxæmic disease, but no post-mortem evidence of the changes characteristic of death from pregnancy toxæmia has so far been discovered, although a considerable number of cases that have terminated fatally have been recorded. There is therefore not the same sound reason for including it in the toxæmic diseases as there is in the case of eclampsia and pernicious vomiting. It is better to regard it as a disease of the nervous system, the occurrence, or the recrudescence, of which is favoured in some way by pregnancy.

The majority of cases of chorea are of a mild type ; spontaneous abortion occurs in from 10 to 15 per cent., but very few cases terminate fatally. At the same time it must be recognised that cases of great severity sometimes occur which end in death in spite of energetic treatment, including the induction of abortion. Lepage has collected 77 fatal cases, and in nearly half of these abortion failed to arrest the course of the disease. Owing to the variability in type, the mortality rate is difficult to determine and is placed variously at from 5 to 40 per cent. by different writers. Andrews and Wall have reported 40 cases at the London Hospital with 5 deaths, equal to 12·5 per cent. ; in the fatal cases abortion occurred in two spontaneously, and in two others it was induced. Fletcher Shaw has recorded a series of 32 consecutive cases in Manchester without a death.

In cases of exceptional severity where a fatal termination may be feared, the choreic movements become so intense as to prevent the taking of nourishment and to hinder sleep ; there may also be delirium, rise of temperature and of pulse rate.

The *treatment* of this disease in mild cases is satisfactory, and as a rule pregnancy ends favourably both to the mother and the child. Absolute rest in bed and careful feeding are very important. Sedatives such as bromide and chloral should be used sparingly, and chiefly for the purpose of ensuring sleep when this is rendered necessary. The bowels should be kept open freely, and the functions of the skin and kidneys kept active by the ' eliminative ' methods described in connection with the treatment of pernicious vomiting.

In cases which belong to the ' severe ' class, and in which the symptoms of danger just mentioned appear, pregnancy should be terminated by a method which necessitates the minimum of operative interference, and is suitable to the period to which pregnancy has advanced (see p. 582). The undoubted influence of pregnancy in the causation of the disease is a sufficient justification for this procedure, but it will be recollected that a favourable result for this operation cannot be with certainty anticipated.

Herpes gestationis.—This rare affection is believed to be a neuritis of toxæmic origin. It is characterised by multiform skin lesions, the commonest type being crops of papules, vesicles, or pustules of herpetiform character ; they are distributed chiefly upon the buttocks, the flanks, the forearms, and the back of the thighs. Sometimes the disease affects the skin of the whole body, is very intractable, and may cause serious exhaustion from uncontrollable irritation and want of sleep.

Appendicitis.—This disease is comparatively rare during pregnancy. There is no clinical evidence that pregnant women display any special liability either to an initial attack or to recurrences. The seriousness of the complication when it does occur is, however, unquestionable, especially in the later months of pregnancy. When pus is present there is great risk of the uterine contents becoming infected, even when the abscess has been treated by drainage ; miscarriage occurs in 90 per cent. of such cases (Abrahams), and the *bacillus coli* has been found in the fœtal blood. Following the uterine infection there are risks of septicæmia, or of suppurative disease of the uterine appendages, in the puerperium. These special risks may be regarded as an indication for prompt surgical interference when appendicitis occurs during pregnancy, and the indication is even more emphatic when the illness is a recurrence and not an initial attack. Induction of abortion or of premature labour is not advisable as an alternative to an operation ; it is reasonable to suppose that the rapid reduction

in size of the uterus might be the means of disturbing protective or limiting adhesions, thus facilitating generalisation of infection over the peritoneal cavity. But before the evacuation and drainage of an appendicular abscess infection of the uterine contents may have already occurred ; the risks are therefore not entirely eliminated by the operation. As a rule an infected ovum is quickly expelled without interference, but the advisability of inducing abortion by one of the methods described on p. 584, after the abscess has been evacuated, must be carefully considered. The interests of the mother are predominant, for the chances of the survival of the child, when viable, are very slight.

Ovarian Tumours.—These tumours are not common complications of pregnancy. Cysts are of course much more often met with in the ovary than solid tumours, and pregnancy with a solid ovarian tumour is very uncommon. Small cysts usually give rise to no symptoms ; they may rise above the pelvic brim where they have freedom of movement if the pedicle is sufficiently long. Often, however, they remain in the pouch of Douglas, and in that case pressure symptoms may arise, such as pain, backache, etc., which will lead to their detection. In the absence of symptoms such a tumour may be unnoticed until labour sets in, when it becomes a cause of serious obstruction (see p. 399). Its detection in the pouch of Douglas is an extremely simple matter, as the tumour is pressed down into the pelvis and can be easily felt *per vaginam* and *per rectum*. Large cysts may be met with in the abdominal cavity, and difficult points of differential diagnosis may then arise which have already been referred to (p. 84), the condition most difficult to distinguish being an abnormally large uterus, as from hydramnios or multiple pregnancy. Malignant ovarian growths are occasionally met with in pregnancy ; the malignant tumour grows rapidly, and the writers have recently seen a case in which there was general peritoneal dissemination and formation of large quantities of ascitic fluid at the sixth month of pregnancy. All ovarian tumours are especially liable to the risk of axial rotation (torsion of the pedicle) during pregnancy or after labour.

As a rule, ovarian tumours discovered during pregnancy should be at once removed ; ovariotomy in pregnant women is no more serious than in the non-pregnant. There is, however, considerable risk of abortion following the operation. During the first two months of pregnancy the risk of post-operative abortion is high (16 to 17 per cent.) ; it then decreases and remains comparatively low until the seventh month, when it again rises and is estimated by some observers as high as 20 to 25 per cent. It follows that the time for performing ovariotomy should be carefully chosen, in uncomplicated cases, with a view to diminishing the risks to the child.

Tumours of the Gravid Uterus—I. Fibroids and Pregnancy.—Conception does not readily occur in a uterus which is the seat of a fibroid tumour when that tumour is submucous or interstitial in position, whether it is small or large. Subperitoneal fibroids, however, are probably no hindrance to conception, whatever their size may be. And although the first-named varieties are a hindrance to conception, they by no means absolutely prevent it, so that the association of fibroids with pregnancy is not uncommon.

The Diagnosis of Pregnancy in a uterus enlarged and distorted by the presence of one or more fibroid tumours may

FIG. 86.—Pregnancy with Multiple Fibroid Tumours of the Uterus. The Placental Insertion lies partly in the Lower Uterine Segment. (Bland-Sutton.)

present great difficulties. The degree of difficulty will depend in the main upon the position of the uterine cavity and its relation to the tumour or tumours. Sometimes the cavity is anterior and accessible to abdominal palpation, when diagnosis will be comparatively easy ; but it may lie behind the tumour which intervenes between it and the abdominal wall ; or it may be placed between two tumours, when diagnosis will be very difficult. Until the presence of the fœtus can be directly detected by palpation, or by auscultation of the heart, the diagnosis of pregnancy can only be presumptive. During the first five months the greatest importance must be attached to amenorrhœa ; sudden cessation of the menses in a patient

with a fibroid tumour almost invariably implies pregnancy, unless the age of the menopause has been reached. But sometimes irregular hæmorrhage takes the place of amenorrhœa, and this change is not so significant, as it frequently occurs in connection with fibroids from other causes. Signs of activity in the breasts carry, perhaps, less than their usual importance in these cases, because secretion is sometimes found in the breasts of nulliparous, non-pregnant women who are the subjects of uterine fibroids. Pregnancy causes rapid enlargement with softening of the uterus and, to a less extent, of the tumours which it contains. Owing to the distortion caused by the new growths, the alterations in shape characteristic of the early months of pregnancy cannot be made out, while softening of the cervix is usually late in appearing. A uterine souffle can often be heard over some part of a non-gravid fibroid uterus, so that the presence of this sign also is unimportant. It will thus be readily seen that diagnosis must be difficult at this stage of pregnancy ; repeated examinations will be required, and even then it may be necessary to postpone diagnosis until the period at which the fœtal heart can be heard. A radiogram is of the greatest assistance in diagnosis, and may reveal the presence of a fœtus as early as the sixteenth week of pregnancy.

During the later months the gravid part of the uterus may be found to occupy almost any position with regard to the tumour ; usually it is placed more or less laterally, but may be in the upper or lower portions of the mass. Upon its position will depend the degree of ease with which the fœtal heart or limbs can be detected.

Clinical Course.—Pregnancy certainly causes recognisable softening of fibroid tumours, but opinions differ as to whether it causes their rate of growth to increase, and the truth is not easy to establish. Upon the general course of pregnancy and the development of the fœtus fibroids exert no unfavourable influence, unless some complication should arise. A fibroid tumour impacted in the pelvis may cause severe pressure symptoms as the uterus develops, but these effects are due to the accident of its position. Axial rotation of a stalked subperitoneal fibroid may occur, though very rarely, during pregnancy ; and previously existing adhesions may become troublesome through being stretched. In the majority of cases the course of pregnancy is attended by very little more discomfort than may be met with when there are no fibroids present ; but if the tumours are unusually large the patient may experience great abdominal discomfort, and even pain, from pressure. There is, however, undoubtedly a somewhat greater risk of pregnancy ending prematurely either in abortion or premature labour. During pregnancy fibroids are peculiarly prone to undergo 'red degeneration' or 'necrobiosis' ; the

tumour becomes tender and painful, and there may be a rise of temperature and constitutional symptoms. The condition seldom lasts for more than a few days and usually disappears with rest in bed. The effect of fibroids upon labour will be considered in a later section (p. 400).

Management.—Pregnancy should be allowed to continue until term, unless (1) severe complications due to the tumour arise, or (2) the tumour is so situated as inevitably to cause insuperable obstruction during labour. In the former case the offending tumour should, if possible, be removed by myomectomy and the uterus allowed to remain. Even with improved technique this operation is attended with a considerable risk of abortion, for Devine has recently collected 130 cases with an abortion rate of 23 per cent. Subperitoneal growths can be removed with little risk ; but interstitial ones, which must be enucleated from the muscular layer of the uterus, are much more liable to cause abortion. In the latter case there are four possible alternatives : (*a*) abortion may be at once induced ; (*b*) the tumour may be at once removed by myomectomy : this is, however, seldom practicable with growths so situated as to cause obstruction in labour ; (*c*) the pregnancy may be allowed to continue until term, and the child then delivered by Cæsarean section, the uterus being at the same time removed ; (*d*) after extracting the child the tumour may be enucleated and the uterus preserved (Cæsarean myomectomy). The induction of abortion cannot be recommended ; the position of the fibroid tumour necessarily renders dilatation of the cervix difficult, and if interference is necessary to evacuate the uterus, serious mechanical obstacles may have to be overcome. Cæsarean hysterectomy (see p. 658) at or near term is no more serious than hysterectomy at an earlier period when the fœtus is non-viable, and is therefore on the whole the best method of dealing with such cases. Cæsarean myomectomy, although theoretically preferable, is actually a more difficult and dangerous operation than hysterectomy.

II. Malignant Uterine Disease and Pregnancy.—Pregnancy is unknown with carcinoma of the body of the uterus, but may be found associated with sarcoma ; there is reason to believe that in some cases of chorion-epithelioma (deciduoma malignum) this growth has originated during pregnancy. Cancer of the cervix and pregnancy are not infrequently associated, and the diagnosis should present no difficulties. Amenorrhœa may be obscured by irregular hæmorrhage from the growth, and of course the condition of the cervix prohibits the characteristic softening of pregnancy from taking place.

Management.—When the cervical carcinoma is in the *operable* stage pregnancy should be ignored, and the whole uterus removed with the disease. The method of operating will

depend upon the size of the uterus—*i.e.*, the stage of pregnancy ; if the fœtus is viable it can be first delivered by Cæsarean section ; if non-viable the uterus can be removed by abdominal hysterectomy, the method of Wertheim being the most suitable. When the disease is *inoperable* abortion may be induced in the early months ; but in advanced pregnancy it is better to wait, and then deliver the child by Cæsarean section at term. Supra-vaginal hysterectomy at a level where non-malignant tissues are present should be performed to avoid the risk of infection of the placental site from the primary growth.

Abortion : Miscarriage.

Abortion is the expulsion of the ovum from the uterus at a period before the fœtus has become viable, the term *viable* signifying that the fœtus is capable of maintaining its existence when born. Until the middle of the seventh calendar month (twenty-eighth week) the fœtus is non-viable ; therefore pregnancy terminating before this date is said to terminate by abortion. The term *miscarriage* is best employed as a synonym of abortion ; sometimes, however, the latter is used only during the first two to two and a half months, when the ovum possesses no properly developed placenta, while the former is applied to all stages of the non-viable period later than this. Such a distinction is confusing and has nothing to commend it, because the process is scarcely affected by the presence or absence of the placenta. Abortion is a miniature labour consisting of a stage of dilatation, a stage of expulsion, and a stage of retraction. It may occur spontaneously or be intentionally induced ; the former alone will be considered here, the latter being dealt with among the Obstetric Operations.

Causation.—The causes of abortion are very numerous ; they will be best considered in three groups : (1) *pathological conditions* of the mother and of the ovum (including the fœtus) ; (2) *traumatic causes ;* (3) *general or systemic causes.*

(1) The *pathological conditions*, maternal and fœtal, which may cause abortion have been already tabulated (see p. 95), and the more important ones fully considered as disorders of, or associated with, pregnancy, and need not be again set out. Of these conditions, some are very apt to cause abortion, others rarely cause it ; and, from what has been said of each, no difficulty will be experienced in distinguishing between those which are important in this respect and those which are not. From the investigations of Mall it appears that one of the most usual causes of early abortion is abnormalities of the embryo which are inconsistent with life or would have resulted in monstrosities had pregnancy persisted ; it appears that such conditions are present in about one-third of early abortions.

A certain number of abortions may be due to low implantation of the ovum in the uterus (*Placenta prævia*). After the ovum has been expelled it is impossible to demonstrate the position which it occupied, but occasional opportunities arise of investigating such ova *in situ*, when the conditions are seen to be very favourable to the occurrence of abortion.

(2) Of the traumatic causes the most important is *injury to the uterus or the uterine contents*. This may occur in a variety of ways, as from direct violence, such as blows or kicks on the abdomen, or from severe falls or other accidents. Sometimes the uterus is actually ruptured by a blow on the abdomen; both blows and falls, however, usually operate, not by injuring the uterus, but by causing detachment of some part of the ovum from the uterine wall. Abortion may be brought about by passing the sound or some other instrument into the uterine cavity, either inadvertently, or with the intention of setting up a miscarriage. Sometimes, however, the passing of the sound into the uterus does not produce this effect. Unless some definite injury is caused to the ovum, such as rupture of the chorionic sac, or partial detachment, no harm follows; there is no doubt that the sound may be passed into the decidual cavity without injuring the ovum at all. If infection is carried into the uterus by dirty instruments abortion may be brought about by septic endometritis. Operations upon the gravid uterus or the uterine appendages are frequently, though by no means invariably, followed by abortion, which in this case probably results from disturbance of the uterine or pelvic circulation. Injury to the ovum does not necessarily produce abortion immediately, an interval of several days, or even a week or two, elapsing before abortion sets in.

Next in importance to direct or indirect injury must be placed a group of conditions which cause abortion by *exciting the uterine centre* situated in the lumbar enlargement of the spinal cord (see p. 244), the stimulus being conveyed through the central nervous system. Extreme degrees of grief or fright, as from sudden bereavement or personal danger, may cause abortion, especially in women of nervous temperament; and it is clear that such conditions can only operate in the manner just indicated. Over-fatigue probably acts in the same way. Operations upon distant parts performed during pregnancy also sometimes induce abortion, which must clearly be produced through the central nervous system. These conditions, all of which cause 'shock' to important nerve-centres, may be justly classed as traumatic.

Many drugs have from time to time been employed for the illicit production of abortion (abortifacients), but no scientific study of their mode of action has ever been made. The salts of

lead, quinine and ergot are common examples ; to produce an effect they must all be taken in poisonous doses.

(3) The *general or systematic causes* consist of a number of conditions the action of which in causing abortion is imperfectly understood. Thus consanguinity of the parents, high altitude, and hot climate are all believed to cause it. Unhealthy occupations pursued by the mother alone or by both parents, such as working with lead, mercury, or glass, undoubtedly also cause abortion. Habitual over-indulgence in alcohol and excessive sexual intercourse are said to favour its occurrence.

It is now known that the importance of syphilis as a cause of abortion has been grossly exaggerated (see p. 171).

It must be added that the cause of abortion in a particular case is often very difficult to trace ; and in exceptional cases an apparently healthy patient may have a series of abortions for which no adequate explanation can be discovered. When associated disorders and traumatic and other known causes of abortion can be excluded, the most probable cause is an unhealthy condition of the endometrium (decidual endometritis, atrophy of the endometrium) upon which the ovum was embedded, and to this condition a series of abortions may be due.

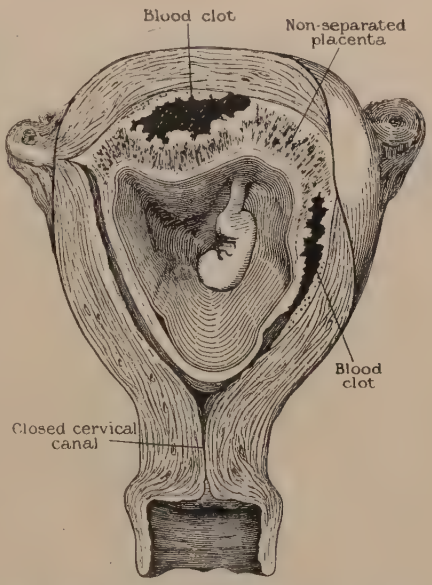


FIG. 87.—Abortion : Stage I. Ovum partially detached, Cervix closed. (Edgar.)

Frequency.—It will be clear from this enumeration of the conditions which cause it that abortion is not an uncommon event. From statistics presented by Professor Malins to the Obstetrical Society of London it appears that in this country about 16 per cent. of pregnancies terminate by abortion—*i.e.*, one abortion occurs to every five births of viable children ; and further it appears that abortion is nearly twice as frequent among the classes from which hospital patients are drawn as among the well-to-do. Presented in another way, it may be said that from 30 to 40 per cent. of all fertile women pass through one or more abortions during the period of child-bear-

ing. Far more abortions occur in the third month of pregnancy than in any other month. Women who are the subjects of Bright's disease often sustain a succession of abortions without carrying any pregnancy to term.

Clinical Features.—The symptoms which accompany the process of abortion are *hæmorrhage and pain*. Hæmorrhage is almost invariably the initial symptom, and is caused by separation of the ovum or of some part of the decidua from the uterine wall (Fig. 87). The bleeding is usually slight at first, but as the abortion proceeds it may become profuse, and dangerous, or even fatal in its severity. Clots form in the vagina, and more rarely in the uterus itself, when bleeding is free. A young ovum of six to ten weeks with its membranes may be discharged either entire or piecemeal along with these clots and thus be overlooked. Pain is usually intermittent, and is due to uterine contractions. Sometimes it is continuous, and the uterus when examined may be hard and unchanging in consistence ; at other times the whole process may be attended with little or no pain. After the discharge of the ovum from the uterus the pain ceases.

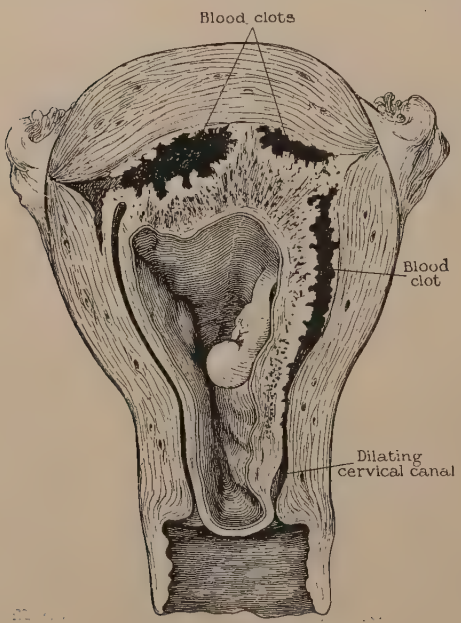


FIG. 88.—Abortion : Stage II. Ovum almost completely detached. Cervix dilated, Lower Pole of Ovum protruding. (Edgar.)

On vaginal examination *dilatation of the internal os* can usually be recognised soon after the onset of these symptoms. The student must recollect that in a multipara the external os is often patulous under ordinary conditions, allowing of the introduction of the finger-tip into the cervical canal ; but the internal os is never opened early in pregnancy except by active contractions. In the dilating cervical canal the finger will often feel a soft, somewhat bulging swelling, which may be a clot of blood, or the lower pole of the ovum detached from the uterine wall and lying free in the lower part of the uterine cavity and cervix (Fig. 88) Sometimes dilatation of the

cervix proceeds irregularly, the external os opening last after the internal os has been already fully dilated ; this offers some difficulties in diagnosis, for the condition of the cervix within the external os cannot well be recognised.

When the cervical canal is sufficiently dilated, the ovum is expelled through it by the uterine contractions, either entire or in pieces ; an early ovum discharged in pieces may escape notice unless all the blood and blood-clot passed by the patient is carefully examined. The uterus rapidly retracts, and the cervix closes down, so that in a few hours no trace of dilatation can be detected, and the consistence of the uterine body is firm. For several days a hæmorrhagic discharge occurs, similar to the lochial discharge of the puerperium, and the uterus itself undergoes a process of involution similar to puerperal involution. If a portion of the ovum or decidua remains unexpelled from the uterus, the hæmorrhage will continue until it has been got rid of, and involution will be arrested.

A number of terms are in common use in this country which are intended to describe certain clinical varieties or phases of the process of abortion ; thus we speak of *threatened* abortion, *inevitable* abortion, *incomplete* abortion, and *missed* abortion.

Threatened Abortion.—Sometimes pain and hæmorrhage occur during early pregnancy without leading to dilatation of the cervix. Caution must be exercised in attributing these symptoms in all cases to threatened abortion, for they may result from a number of other causes—*e.g.*, the bleeding may not come from the body of the uterus at all, but from some concurrent disease of the cervix, such as a polypus or a malignant growth. And when the bleeding can be clearly traced to the uterine cavity, abortion by no means always ensues : it is certain that a good deal of hæmorrhage may occur in early pregnancy without causing detachment of the ovum. For example, hæmorrhage may occur from the undetached decidua in decidual endometritis, or in connection with cardiac or hepatic disease of the mother. It is even possible that slight detachment of some part of the ovum or the decidua itself may be repaired and the gestation allowed to continue. In Fig. 89 it is seen that considerable hæmorrhage has occurred into the decidual space without separation of the ovum, which is intact, though somewhat compressed. Clinically, the bleeding in this case was attributed to the coincident malignant disease of the cervix. Whatever may be the explanation, it is certain from clinical experience that one or more smart hæmorrhages in early pregnancy, or slight bleeding continued for several weeks, are not incompatible with the completion of gestation and the birth of a healthy child. Pain and hæmorrhage must therefore never be regarded as certain indications of abortion unless they are accompanied by dilatation of the internal os, or the expul-

sion of some part of the ovum (fœtal or maternal); when unaccompanied by these changes it is convenient to refer to the

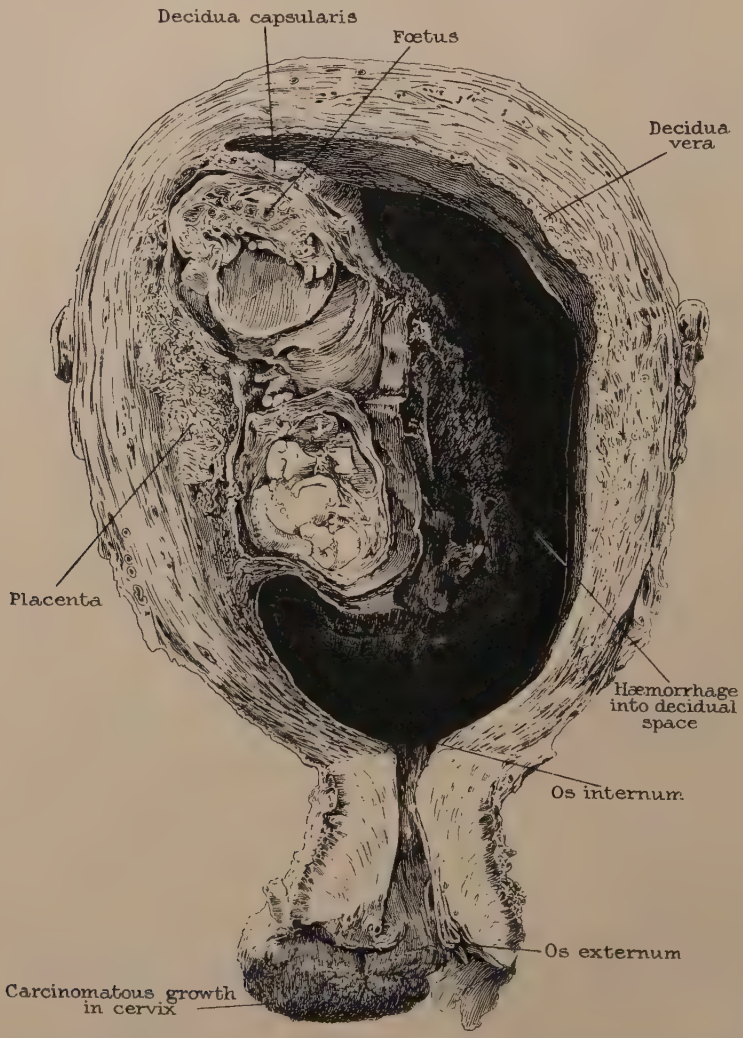


FIG. 89.—Gravid Uterus (Fourth Month), showing extensive Decidual Hæmorrhage without Detachment of the Ovum. (Charing Cross Hospital Museum.)

The uterus was removed for carcinoma of the cervix.

condition as *threatened abortion*. By suitable treatment the process can often be arrested here and the danger averted. It is not uncommon, however, for symptoms of threatened abor-

tion to subside, and after an interval to recur with greater severity. The condition must, however, always be regarded seriously, for alarming and even fatal hæmorrhage may occur from separation of an early ovum without any attempt being made by the uterus to evacuate its contents spontaneously. Such cases, being unattended by dilatation of the cervix, are technically cases of threatened abortion.

Inevitable Abortion.—When the pains are regular and intermittent, when the internal os begins to open, when the ovum has been detached and can be felt in the cervix, when the liquor

FIG. 90.—Two to Three Weeks' Abortion. The Chorionic Sac is partially covered with Villi, and has become attached to a piece of Blood-clot.

amnii has escaped, or when some portion of the decidua has been expelled, the process of abortion cannot be arrested, and is therefore said to be *inevitable*. It is not in all cases easy to say whether or not an abortion is inevitable, unless the finger can be passed up to the internal os, or unless some part of the ovum has been discharged and recognised. Sometimes, however, it is possible to recognise uterine contractions by palpation, and this forms a useful sign, for in threatened abortion the uterus does not contract sufficiently to be recognisable by palpation. During a contraction the uterus becomes uniformly hard in consistence, and often a little irregular in shape; the contraction

may be very prolonged, lasting for several minutes. In the early stages this sign is sometimes useful in diagnosis, but eventually dilatation of the cervix is the change upon which the recognition of an inevitable abortion depends. The distinction

FIG. 91.—Six Weeks' Abortion. The Ovum has escaped from the Decidua Capsularis; the Chorion has ruptured; the Amnion is entire. (Charing Cross Hospital Museum.)

between threatened and inevitable abortion is an important practical point, for the two phases must be differently treated.

Incomplete Abortion.—This name implies that some portion of the placenta or of the decidua has been retained in the uterus. Continuance of bleeding, with absence of the expected

involution of the uterus, are the chief symptoms ; to these may be added those of septic infection, if the cavity of the uterus has not been kept sterile.

Missed Abortion.—This term has already been explained when describing the fleshy or carneous mole (p. 141). Symptoms of threatened abortion occur, which subside, and after a variable period a mole is expelled.

Anatomy of Abortion.—The condition of the ovum when expelled depends partly upon its period of gestation, and partly

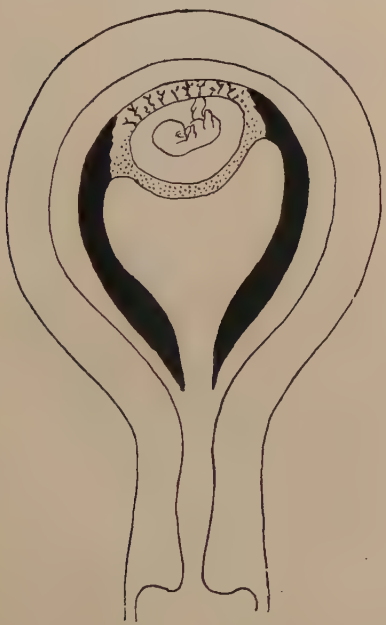


FIG. 92.—Normal Anatomical Arrangement in the first Two Months of Pregnancy.

FIG. 93.—Mechanism of Abortion in the early Months, with Inversion of the Decidua Vera.

(Galabin and Blacker.)

upon the changes which it has previously undergone. The great majority of aborted ova show no recognisable morbid change ; they were apparently healthy up to the time of their expulsion. Others show various stages of the blood-mole previously described, or of the hydatidiform mole, these, of course, being ova of the first three months of gestation. Older ova which possess a definite placenta, when retained for some weeks after the death of the fœtus, show well-defined post-mortem changes, including those already described as placental infarcts. In some cases infection has occurred previous to the

abortion, and the tissues of the ovum may then be expelled in a state of decomposition and having an offensive odour.

Ova apparently healthy may be expelled entire—with or without the maternal coverings—or piecemeal. During the first and second months the ovum, when thrown off, may carry with it all the decidual coverings, the whole contents of the

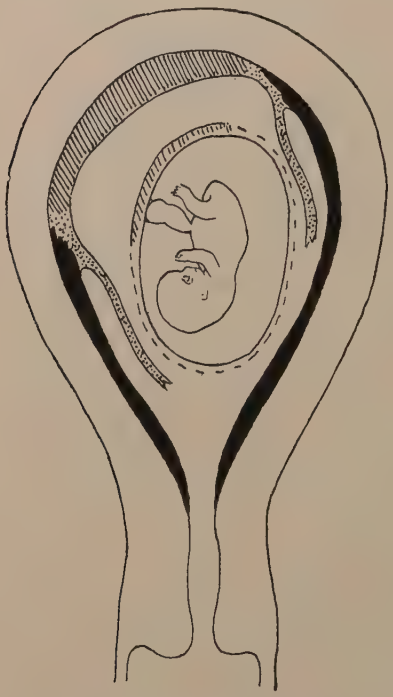


FIG. 94.—Mechanism of Abortion in cases where the greater part of the Decidua Basalis, together with the Decidua Vera and Capsularis, is left *in utero*.

FIG. 95.—Mechanism of Abortion, the Fœtus expelled in the Intact Amnion.

(Galabin and Blacker.)

uterus being thus evacuated *en bloc*. More frequently the decidua capsularis is ruptured, and the ovum (chorion, amnion, and fœtus) escapes and is expelled entire through the cervix (Figs. 92 and 93). The attachments of the chorion to the decidua are so delicate at this period that the force of the uterine contractions alone severs them completely. After the second month the chorion as well as the decidua is usually ruptured (Fig. 95); the amnion, being more elastic, resists,

but it also may be ruptured, and then the fœtus escapes and may be lost in the discharged blood. Often the chorion and decidua are so firmly attached to each other and to the uterus that a portion of chorion remains, making the abortion incomplete ; this is more apt to occur with the placental chorion than with the chorion læve.

The period of gestation to which the ovum belongs may be estimated from the size and characters of the fœtus, or from the size of the chorionic sac when entire. The size and characters of the fœtus at different periods of development have been stated on p. 50 ; they form the best guide to the period of development of the ovum. When the fœtus has been lost other criteria must be relied upon. The size of the unruptured chorionic sac is the next best guide ; during the first three months it is as follows :

4th week	.	.	about 1	×	$\frac{3}{4}$ of an inch	(2·5	×	2 cm.).
8th ,,	.	.	,, 2	×	$1\frac{3}{4}$ inches	(5	×	4 cm.).
12th ,,	.	.	,, $4\frac{1}{2}$	×	$4\frac{1}{2}$,,	($11\frac{1}{2}$	×	$11\frac{1}{2}$ cm.).

Up to the eighth or ninth week the whole chorion is covered with villi ; then those of the chorion læve atrophy, and by the end of the third month the discoidal placenta has been definitely outlined. It seldom happens that a fœtus of the size of three months' development escapes recognition in a miscarriage.

Differential Diagnosis.—Two other conditions resemble abortion inasmuch as they are characterised by the expulsion of a body from the uterus with hæmorrhage and pain ; they are (1) *tubal gestation* and (2) an *intra-uterine polypus*.

(1) The former has already been referred to (p. 160). It has been pointed out that the structure of the decidual membrane is identical in both uterine and extra-uterine pregnancy, and therefore uterine abortion cannot be diagnosed unless structures recognisable as chorionic or fœtal have been expelled from the uterus. An important clinical distinction is that in abortion pain is slight and hæmorrhage is considerable, whereas in tubal gestation pain is extremely severe and hæmorrhage is slight. (2) An intra-uterine polypus sometimes protrudes through the cervix, either with or without complete detachment. Hæmorrhage, pain, enlargement of the uterus, dilatation of the internal os, and the presence of a soft bulging swelling in the cervical canal may appear to justify a diagnosis of inevitable abortion. But further inquiry and examination will serve to distinguish the two, for with a polypus a period of amenorrhœa is unlikely, and the customary signs and symptoms of pregnancy will be absent.

It must also be borne in mind that *during menstruation* the uterus undergoes changes similar to those found at the begin-

ning of an abortion, *i.e.*, the uterine body is softened, and the cervix undergoes slight dilatation. In the case of women who menstruate irregularly, the occurrence of bleeding after a prolonged interval may be regarded as an abortion unless attention is paid to the points just mentioned. During a menstrual period no membrane is discharged except in the rare cases of 'membranous dysmenorrhœa,' and in these cases the

FIG. 96.—Two and a Half Months' Abortion. (Charing Cross Hospital Museum.)

membrane can be distinguished by microscopic examination from the decidua of pregnancy.

Treatment.—*Prophylactic* treatment is naturally of great importance. An attempt should therefore be made in all cases to discover the cause of an abortion, and if several have occurred it is very necessary that every possible avenue of explanation should be explored. The urine should be tested for albumen, the blood-pressure measured, the Wassermann test applied, and the patient subjected to a thorough physical examination. A careful pelvic examination should also be made after the patient

has recovered from the abortion, in order that local causes, such as displacements and chronic endometritis, may be excluded.

The cause having been detected, prophylaxis is very hopeful. Many of the conditions described as *systemic causes* are curable by appropriate treatment. In cases of syphilis both parents should undergo a full course of salvarsan injections followed by mercury; the prospect of cure and of the birth of healthy children is good in all these cases. Curetting is useful in cases of chronic endometritis, and if no constitutional cause can be discovered it is beneficial even when the local signs of chronic endometritis cannot be detected. Careful management of the early months is necessary after several consecutive abortions, and it is a popular belief, which is supported to some extent by clinical experience, that the menstrual epochs are times of greater danger. The patient should therefore stay in bed for three to four days every four weeks as the menstrual times come round. Complete confinement to bed is seldom necessary or desirable so long as the general health is not definitely impaired.

An important point in prophylaxis is that local examination of the uterus during the first three months should be conducted with great care and gentleness, and should not be repeated unnecessarily. In cases of backward displacement unaccompanied by symptoms, abortion has frequently been caused by attempts to replace the uterus; replacement, it will be recollected, is unnecessary until definite symptoms supervene, and should, therefore, be avoided.

In *threatened* abortion the object of treatment is to arrest the process; in *inevitable* abortion the object is to assist it.

Threatened abortion is accordingly treated by confining the patient strictly to bed, by avoiding as far as possible all forms of exertion and excitement, and by the administration of sedatives. No local treatment should be adopted. After the first examination from which it has been recognised that the abortion is not inevitable, no further vaginal examination should be made unless the case proceeds unfavourably. The diet should be kept low and no alcohol given, the bowels not allowed to become confined. Various sedative drugs may be administered. The most generally useful drug is opium, and the treatment may be begun with a hypodermic injection of a quarter of a grain of morphia, and the action of the drug maintained for two or three days by small repeated doses of opium pill or laudanum. Bromide of potassium and chloral hydrate are useful in patients of excitable temperament. After a threatened abortion the patient should be kept in bed for at least a week after all bleeding has ceased. If the symptoms recur the same rule must be strictly followed.

A case of threatened abortion may at any time become inevitable, requiring a prompt change of treatment. In any case where the amount of bleeding is sufficiently profuse seriously to affect the patient's condition, the treatment of inevitable abortion must be adopted, even if there is no dilatation of the cervix.

Inevitable Abortion.—In many cases this process will proceed naturally, and terminate without any interference on the part of the medical practitioner, and with a perfectly favourable result. Under such circumstances nothing is required beyond the administration of ergot in full doses (one drachm of liquid extract, or 3 gr. of ergotin every four hours), which is useful in stimulating the uterus, preventing retention of fragments of the decidua or ovum, and ensuring proper retraction afterwards.

In conducting even the simplest case of inevitable abortion two points are of the greatest importance. Firstly, all blood-

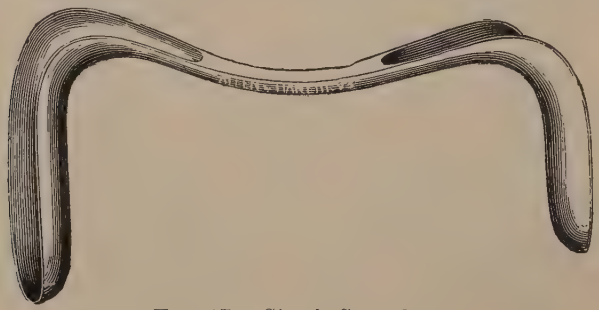


Fig. 97.—Sims's Speculum.

clot and blood-stained coverings must be carefully examined, as the uterine contents may be discharged piecemeal ; the nurse must accordingly be instructed to save everything for the inspection of the medical attendant. Secondly, the strictest aseptic precautions must be observed throughout.

It must be understood that the management of an abortion calls for the greatest possible care in the prevention of infection, and the aseptic routine to be described later on for the management of normal labour (see p. 272) must be applied just as thoroughly and conscientiously to a case of abortion. The results of infection may be quite as serious or even as disastrous as those of ordinary puerperal infection.

Interference during the course of an inevitable abortion may become necessary from excessive hæmorrhage, from rise of temperature, or from inability of the uterus completely to expel its contents (incomplete abortion). *Hæmorrhage* may become profuse or even dangerous at any stage of the process ; it is of course due in the early stages to the separation of the ovum

from the uterine wall and the consequent rupture of maternal vessels. The hæmorrhage abates to some extent when the ovum has been completely separated, even when it is not yet expelled from the uterine cavity; but while any portion remains undetached it will continue. *Rise of temperature* during a miscarriage necessarily arouses suspicion of infection, and is always to be regarded as an indication for terminating the process by immediate evacuation of the uterus in the manner described below. Finally, from *slow dilatation* of the cervix, from morbid adhesion of some part of the ovum, or from *weak contractions*, the abortion may be so much delayed as to require interference. In abortion occurring during the first two months there is considerable risk of retention of a portion or even of the whole of the decidua. Unless the whole of this membrane is found in the discharges, the case should be treated as an incomplete abortion in the manner described below. Retained

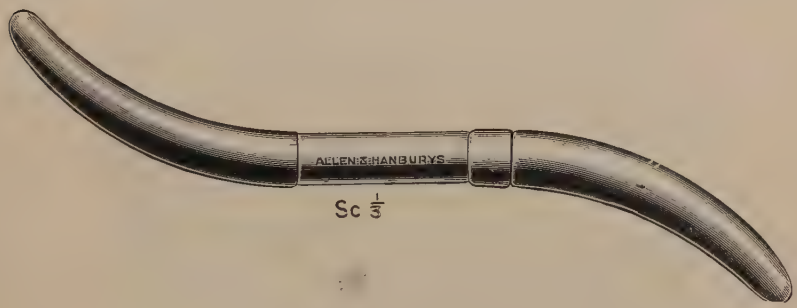


FIG. 98.—Fenton's Uterine Dilator.

decidua is a fertile source of hæmorrhage, and also predisposes to septic infection.

Whenever surgical interference is required to terminate a miscarriage the method adopted should be the same, viz., immediate evacuation of the uterus under anæsthesia.

Immediate Evacuation of the Uterus.—After aseptic preparation of the area of operation, under anæsthesia the cervix is first exposed with a speculum such as that of Sims, and then seized with volsellum forceps. The vaginal walls and cervix are next swabbed with tincture of iodine. Dilatation may be performed by means of graduated metal cervical dilators (Fig. 98) until the index finger can be introduced easily into the uterus. This will allow sufficient room to remove a two and a half months' miscarriage; for cases more advanced than this incision of the cervix may be practised as in vaginal Cæsarean section (Fig. 661). The uterine body should then be gently pressed down with one hand above the pubes, until the finger in the cervix can be worked thoroughly into the cavity. The

dilatation and subsequent digital exploration must be carried out gently, for otherwise the cervix may be severely torn. The ovum must next be completely detached with the finger-tip, special attention being paid to the uterine angles. The finger should then be removed from the uterus, and by compressing the uterine body between the external hand and two fingers in the vagina the whole contents may be squeezed out. If this

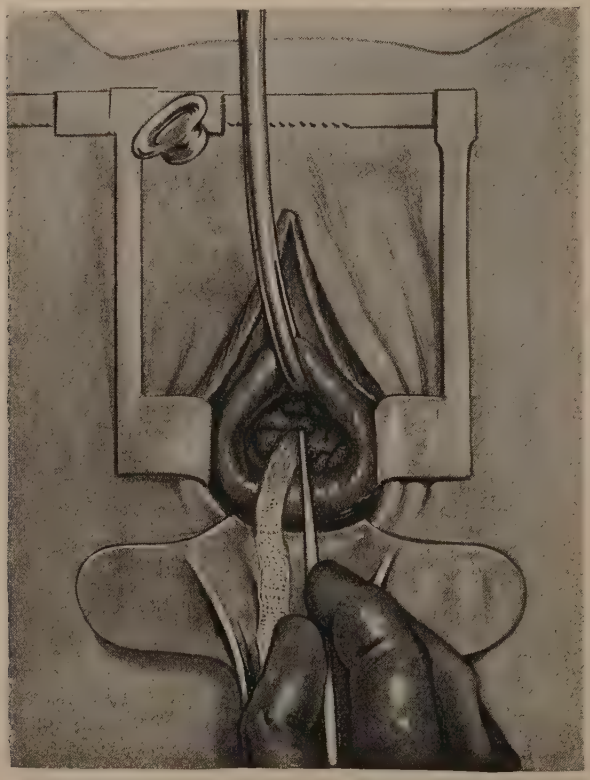


Fig. 99.—Plugging the Uterine Cavity for Hæmorrhage.

should not succeed, a pair of blunt ovum forceps (Fig. 102) may be passed into the uterus and the ovum removed gently.

It is difficult to detach the decidual membrane with the finger, and a blunt flushing curette should be next employed to detach and remove it. The curette must be used with gentleness, and the whole uterine wall scraped from above downwards ; large pieces of thick membrane will thus be removed. The finger should then be passed again to make sure that the uterus has been completely emptied. Next the empty uterus is

massaged firmly between two or three fingers passed into the vagina and the other hand placed above the pubes, and to do this properly the organ should be first anteverted. This squeezes out blood and promotes uterine retraction, thus

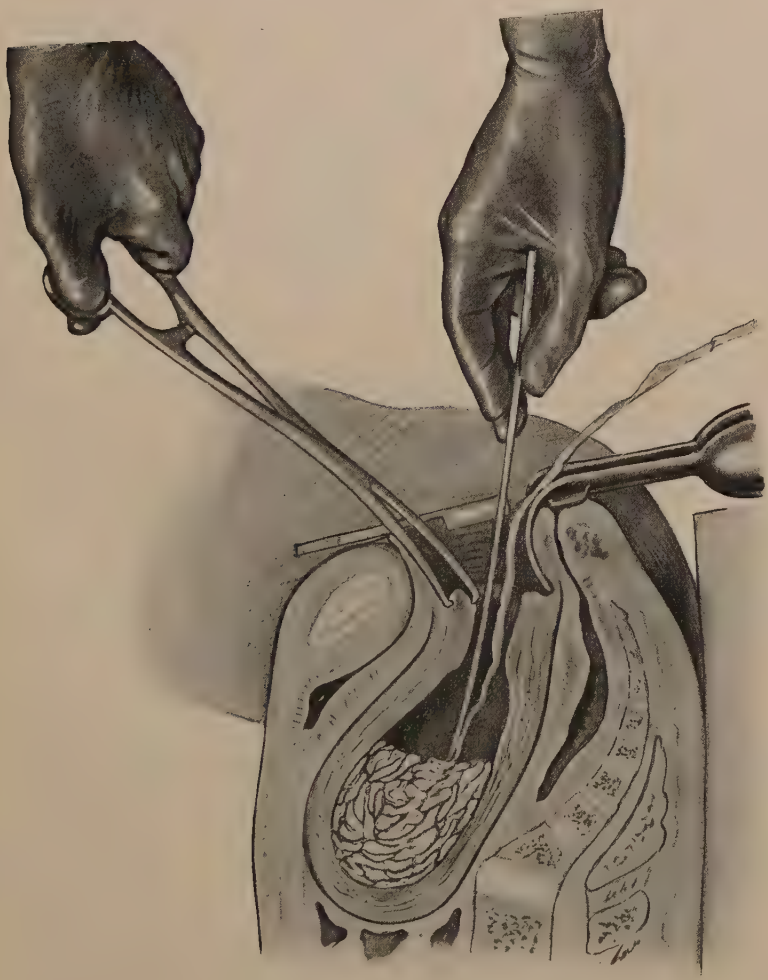


Fig. 100.—Plugging the Uterine Cavity for Hæmorrhage.

arresting hæmorrhage. Finally, both the uterus and vagina should be carefully douched with a hot antiseptic solution, such as lysol, a drachm to a quart (temperature 120° Fahr.).

If these methods do not suffice to arrest bleeding, the finger should be again passed to make sure that no part of the ovum remains attached to the uterus. If it is certain that the uterine

cavity is empty it must be plugged to arrest the bleeding. This should be done carefully in the manner shown in Figs. 99 and 100. The cervix is first exposed with vaginal specula, seized with a volsella, and drawn down to the vulva. Then a long piece of 1-inch or 2-inch sterile gauze, or iodoform

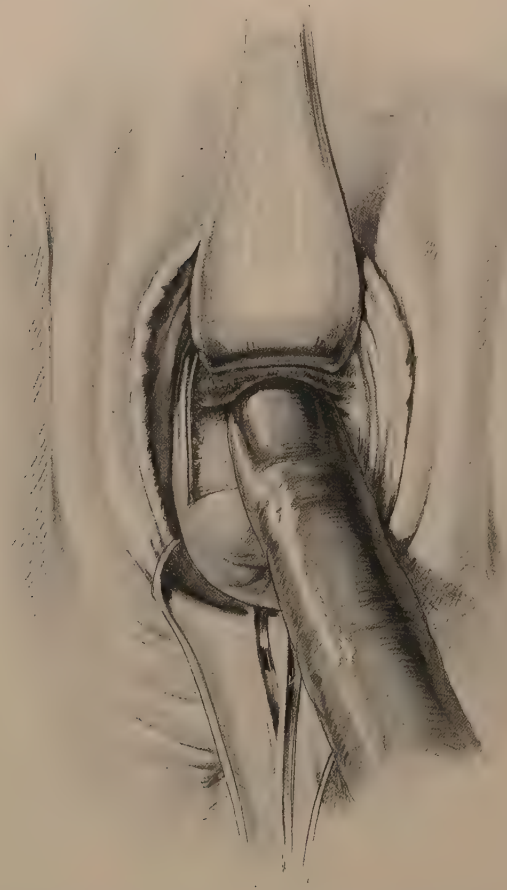


Fig. 101.—Separation of the Bladder from the front of the Cervix to the level of the Utero-vesical Pouch.

gauze, is passed with a probe so as to fill tightly the uterus from the fundus downwards. The vagina need be only loosely plugged. Finally 1 c.c. of pituitrin is to be administered by intra-muscular injection. The gauze must be removed in 12 hours, as there will be no further risk of hæmorrhage after that interval.

The strictest antiseptic precautions are called for in performing the operation of evacuation of the uterus ; the vulva should be shaved and swabbed with tincture of iodine, the vaginal walls swabbed with it also, and sterilised rubber gloves should be used by the operator (see p. 579).

Septic Abortion.—Evacuation of the uterus by the above method should be almost devoid of risk under ordinary conditions. Occasionally, however, cases come first under treatment after acute septic infection has occurred, and the whole or a part of the ovum is still in the uterus. The greater number of such cases are the work of criminal abortionists. The process of clearing out the uterus is then attended by considerable danger, for in detaching the placenta or membranes blood-vessels are laid open into which infective material may find direct access during the operation. In this way the

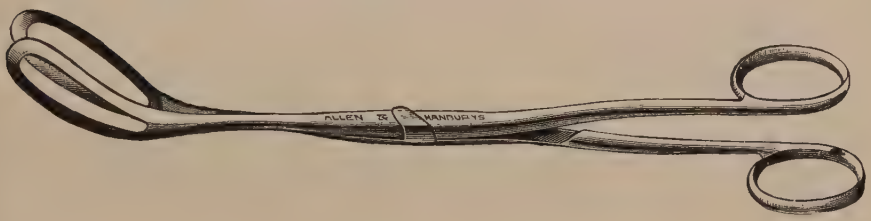


Fig. 102.—Ovum Forceps.

Fig. 103.—Blunt Flushing Curette.

generalisation of the infective process is actually assisted. Nevertheless it is sound practice to follow the surgical rule that actively infected cavities must always be cleared of their contents and freely drained. In performing the operation under these conditions cutting or sharp scraping instruments should be avoided, and the uterus cleared out with the finger alone or aided only by the ovum forceps or blunt flushing curette. A septic uterus also should never be plugged, as free drainage is essential.

Missed Abortion.—It is certain that the uterus contains an ovum which has perished, if actual shrinkage of the organ occurs, and the general signs of pregnancy, such as breast-signs, also subside. As a rule a brownish discharge occurs from the uterus, and menstruation will not return until the uterus has been emptied. It is therefore better to empty the uterus by operation in the manner above described. Owing to the firmness of the thickened membranes the detachment and

removal of the ovum are more difficult than in an ordinary case.

The *after-treatment* of abortion is conducted upon the same principles as the normal puerperium (p. 480). Women of the poorer classes often pay little or no attention to a miscarriage ; they do not seek medical advice, nor do they consider that a subsequent period of rest is necessary. But many forms of chronic pelvic inflammation arise from a neglected miscarriage, and it is the medical man's duty to enforce proper management and an adequate period—at least ten days—of rest in bed.

Part III

NORMAL LABOUR

Labour is the process by which a fœtus of viable age is expelled from the uterus. Labour varies greatly in duration, in severity, and in the amount of risk to mother and fœtus which it involves. By a *normal labour* is meant a case in which the fœtus presents by the vertex, and which terminates naturally, without artificial aid and without complications. Presentation is not the only criterion of normal labour, for even when the presentation is normal, complications may arise which carry the case at once into the category of *abnormal labour*. It follows that abnormal labour is somewhat difficult to define, but for practical purposes we may include under this designation all cases in which some other part than the vertex presents, and all vertex cases in which complications of maternal or fœtal origin arise.

Within the class of *normal labour* many conditions must be recognised which affect the degree of difficulty which may be encountered. Generally speaking, a first labour is more prolonged and more difficult than subsequent ones ; a woman in her first labour is conveniently designated as a *primipara*, in later confinements as a *multipara*. Another factor of considerable importance is *age ;* from eighteen to twenty-three years is the age at which the first labour may be expected to run the easiest and most favourable course. A primipara of over thirty years of age encounters greater risks, which steadily increase in gravity as age advances ; in elderly primiparæ labour is frequently prolonged, and the forceps is much more often required than in young primiparæ. From sixteen to eighteen years of age the difficulties are not materially greater than normal, but below sixteen there is more risk of serious laceration.

Calculation of the Date of Labour.—The date at which labour may be expected is difficult to determine. The average duration of pregnancy in women is generally calculated to be ten lunar months, forty weeks, or two hundred and eighty days, from the beginning of the last menstrual period. This must not, however, be regarded as an exact date, but as the central point of a period of probability ranging from the 274th to the

286th day. The calculation may be made as follows: Last menstruation February 1 to February 5.

February	27 (if Leap Year, 28).
March	31
April	30
May	31
June	30
July	31
August	31
September	30
October	31
November	8
	280

Therefore the confinement may be expected to take place between November 2 and 14. In practice the calculation is conveniently made by adding seven days to the date on which the last menstrual period began and counting forward nine months (or counting back three months). This simple rule will be found always to give an interval of two hundred and eighty days, from whatever day of the year the reckoning be made. When the date of the last menstrual period is not known, or when conception has occurred during a period of amenorrhœa (*e.g.* during lactation), other data must be used. The best possible estimate, but one which is seldom available, is that in which pregnancy can be reckoned from a single coitus, and estimated in this way, the average duration of pregnancy is found to be two hundred and seventy-three days. The date of quickening is unreliable and varies from the sixteenth to the twentieth week, the fœtal movements being appreciated earlier by multiparæ than primigravidæ. The only other criterion of calculation is the height of the uterus above the pubes; the possible sources of fallacy in estimating the duration of pregnancy by this method have already been referred to on p. 84.

Labour may occur at an earlier period than forty weeks when it is said to be *premature;* many of such cases are due to pathological conditions, but sometimes no cause can be assigned. On the other hand, the onset of labour may be delayed considerably beyond the normal period, when it is said to be *postmature.* The fœtus continues to increase in size *in utero* after the period of maturity has been reached.

It is obvious that while the birth of a premature fœtus will be easier, the delivery of a fœtus whose weight and size greatly exceed the normal will be attended by greatly increased risks, and consequently the subject of postmaturity is not without clinical importance. It will be again referred to in connection with the induction of premature labour (p. 584).

The Onset of Labour.—The signs by which the onset of labour is recognised must be clearly understood. They are (1) painful uterine contractions ; (2) slight uterine hæmorrhage —the ' show ' ; (3) commencing dilatation of the internal os ; (4) formation of the ' bag of waters.'

(1) *Painful Uterine Contractions* (Labour Pains).—Reference

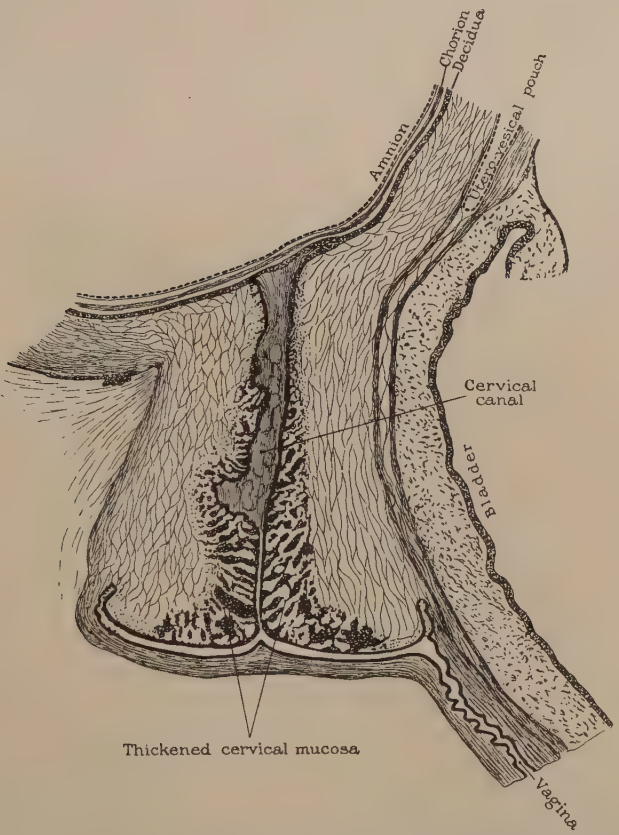


FIG. 104.—Cervix of a Multipara at Term, before Commencement of Labour. From a Frozen Section. (Varnier.)

has already been made to the fact that during the second half of pregnancy intermittent contractions, recognisable on palpation, occur in the wall of the gravid uterus. The patient is unconscious of them, and they produce no effect upon the cervix or ovum. At ' term ' these contractions change their character and become labour pains ; usually the transformation is gradual, vague transient abdominal pain being complained

of by the patient for several days ; sometimes, however, a rapid or sudden onset of labour pains will be met with. At first they are slight, lasting for only half a minute, and separated by intervals of fifteen to thirty minutes ; they are then felt chiefly in the abdomen. More or less rapidly they increase in frequency, severity, and duration. If the abdomen is palpated during a pain, the whole uterus will be felt to harden and become more clearly defined in outline.

In women expecting to be confined, colicky abdominal pains, which may sometimes be mistaken by the patient for labour pains, are apt to occur from such trivial causes as dyspepsia and constipation. They have received the somewhat inept

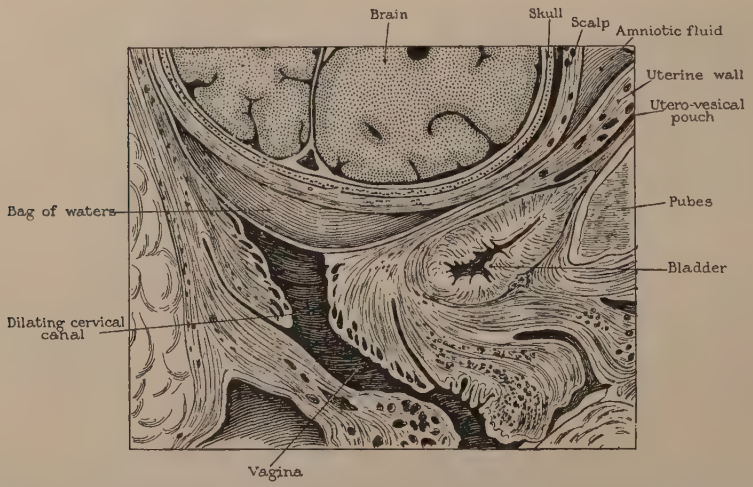


FIG. 105.—Cervix of a Multipara who died of Eclampsia at the beginning of Labour. From a Frozen Section. (Varnier.)

name of 'false pains.' Pain of this description is not accompanied by dilatation of the internal os or contraction of the uterus, and need therefore never be mistaken for labour ; it is best treated by an aperient or an enema.

(2) *The 'Show'* is a discharge of slightly blood-stained mucus. The mucus comes from the cervical mucosa, which secretes abundantly during labour ; the slight hæmorrhage comes from the lower uterine segment, where the beginning of dilatation causes a little separation of the membranes. It is almost invariably met with at the onset of labour.

(3) *Dilatation of the Internal Os.*—The usual condition of the cervix at term, before the onset of labour, is shown in Fig. 104. From this figure it will be seen that the cervix is not shortened ; the canal is intact and closed at both ends. In a multipara the

external os is sometimes patulous, admitting the tip of the index finger, but even then the internal os will usually be found closed before labour. The alterations induced by the onset of labour are shown in Fig. 105, where it will be seen that the cervix is shortened, and the canal open at both ends, the internal os being rather wider than the external. These figures represent the actual conditions found in frozen sections of women who died, the former before labour, the latter soon after its onset ; they have therefore the value of precise anatomical observations. It will be noticed that the dilatation of the internal os is of necessity accompanied by a corresponding stretching of the lowest part of the lower uterine segment. Notwithstanding what has just been said, the internal os is not infrequently found dilated sufficiently to admit the finger tip in women who are not in labour ; this is more frequently found in a multipara than in a primipara. In some cases it is the result of a false start, a few effective pains having occurred and then died away. In others there is no history of definite pains having been felt, and this slightly dilated condition of the internal os may appear two or three weeks before labour actually sets in.

The position is, therefore, that, while a closed cervix is a reliable sign that labour has not begun, a slightly dilated cervix may be found in a woman who is not in labour.

(4) *Formation of the 'Bag of Waters.'*—When the cervix opens, the lower pole of the fœtal membranes (chorion and amnion), which has been already detached by stretching of the lower uterine segment, being unsupported, tends to bulge into the cervical canal. It contains a little liquor amnii which has passed below the presenting part, and it has therefore received the name of the 'bag of waters.' When the finger is passed into the cervix during a pain, this bag will be found to be convex in outline and tense in consistence ; as the pain passes off it becomes less tense and less distinct, and may even disappear altogether as the membranes come into contact again with the head.

Notwithstanding these points, it is at times somewhat difficult to decide from a single examination whether a patient is actually in labour or not. Pains sufficient to open the internal os may occur and then cease, several days or even two or three weeks elapsing before the actual onset of labour. Again, the patient may complain of intermittent pains, and uterine contractions may actually be felt on palpation, yet there may be no dilatation of the cervix at all. It follows that neither painful contractions alone, nor dilatation of the cervix alone, suffice for recognising that labour is actually in progress. But if with intermittent pains and dilatation the bag of waters is felt to grow tense during the pain, and to relax during the interval, the diagnosis of labour is certain. Yet after labour

has actually begun the process is sometimes suspended, and the pains do not start again until an interval of several days has elapsed.

The Stages of Labour.—In this country it is usual to divide the process of labour into three stages. In most instances these stages can be clinically defined with approximate accuracy, but sometimes cases occur in which this is impossible.

First Stage, or Stage of Dilatation.—This stage is preparatory

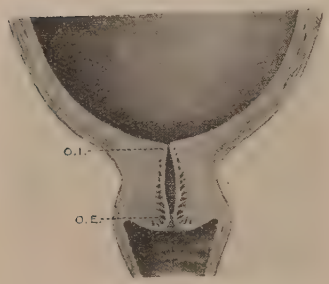


FIG. 106.—Cervix at beginning of labour.

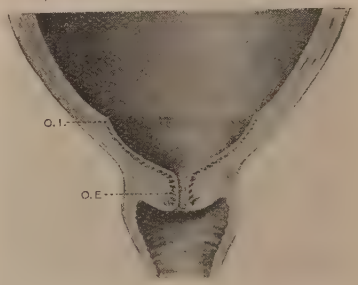


FIG. 107.—Upper half of canal 'taken up.'

FIG. 108.—Canal completely 'taken up,' external os still closed.

FIG. 109.—External os fully dilated; note the thin edges.

Mode of Dilatation of the Cervix in a Primipara. (After Bumm.)

to the actual process of birth—*i.e.*, the expulsion of the fœtus from the uterus. It consists in the dilatation or canalisation of the lower uterine segment and cervix. Clinically its progress can be judged by the changes taking place in the os externum, the cervix, and the bag of waters.

Even when in a multipara the external os is open at the beginning of labour the vaginal portion of the cervix is distinctly felt forming a projection of about half an inch in length. As the internal os opens the upper part of the cervical

canal becomes merged in the lower uterine segment; as the dilatation progresses more of the cervix becomes thus 'taken up' into the uterus, and this change can be detected by the finger as a shortening of the cervical projection on vaginal examination. When no definite cervical projection can be felt the cervix is said to be 'taken up,' although the external os may still be only partially dilated. In a primipara the cervix

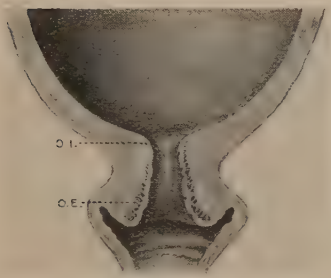


FIG. 110.—Cervix at beginning of Labour.

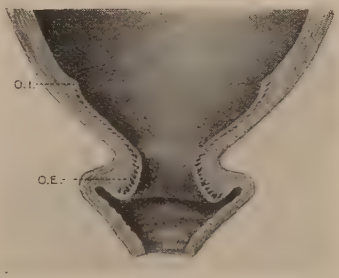


FIG. 111.—Upper half of Canal 'taken up,' and simultaneous dilatation of external os.

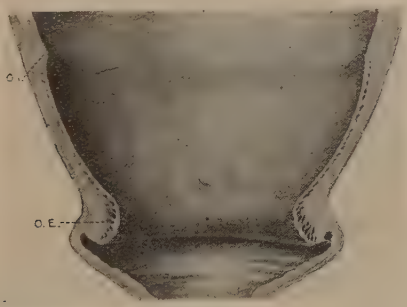


FIG. 112.—Cervix fully dilated; note the thick edges of the external os.

Mode of Dilatation of the Cervix in a Multipara. (After Bumm.)

always dilates in this manner from above downwards; the external os offers great resistance and undergoes little, if any, dilatation until the canal has been completely 'taken up' (Figs. 106 to 109). The os is felt as a small aperture with thin firm edges upon the summit of the convexity of the distended cervix, occupied by the head. In a multipara the external os is as a rule sufficiently open to admit one finger before labour has begun and offers less resistance to the forces of dilatation; the 'taking up' of the canal and the dilatation of the external

os proceed simultaneously, and the fully dilated os presents thick edges (Figs. 110 to 112).

The bag of waters bulges slightly through the dilating external os in the shape of an inverted watch-glass (Figs. 105 and 113); the amount of fluid it contains varies considerably, and upon this its size and shape depend. During the intervals when the bag is lax the fœtal head can be distinctly felt through it. When, as sometimes happens, the membranes rupture before the onset of labour, no bag is as a rule formed,

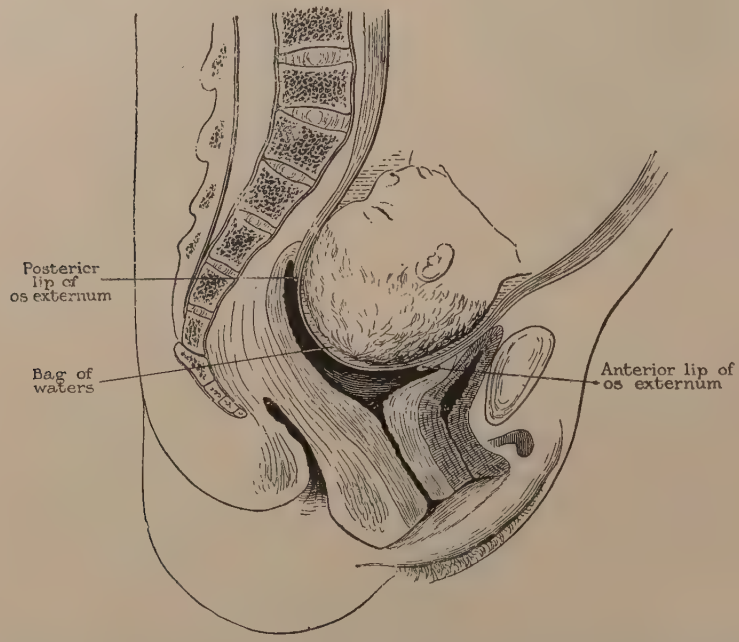


FIG. 113.—End of the First Stage of Labour. The Lower Uterine Segment, Cervix, and Upper Part of the Vagina are dilated. (Modified from Ribemont-Dessaignes and Lepage.)

although exceptions to this may be met with. When dilatation is complete the diameter of the cervical canal is nearly four inches, the presenting part occupies the whole cervical canal, and the edges of the os externum can be felt surrounding it. At this period the bag of waters usually ruptures spontaneously, and a certain amount of liquor amnii escapes, but the greater part is retained in the uterus, the presenting part filling the lower uterine segment and thus acting as a ball-valve. Sometimes, however, rupture of the membranes occurs prematurely in the first stage; or, on the other hand, it may be delayed

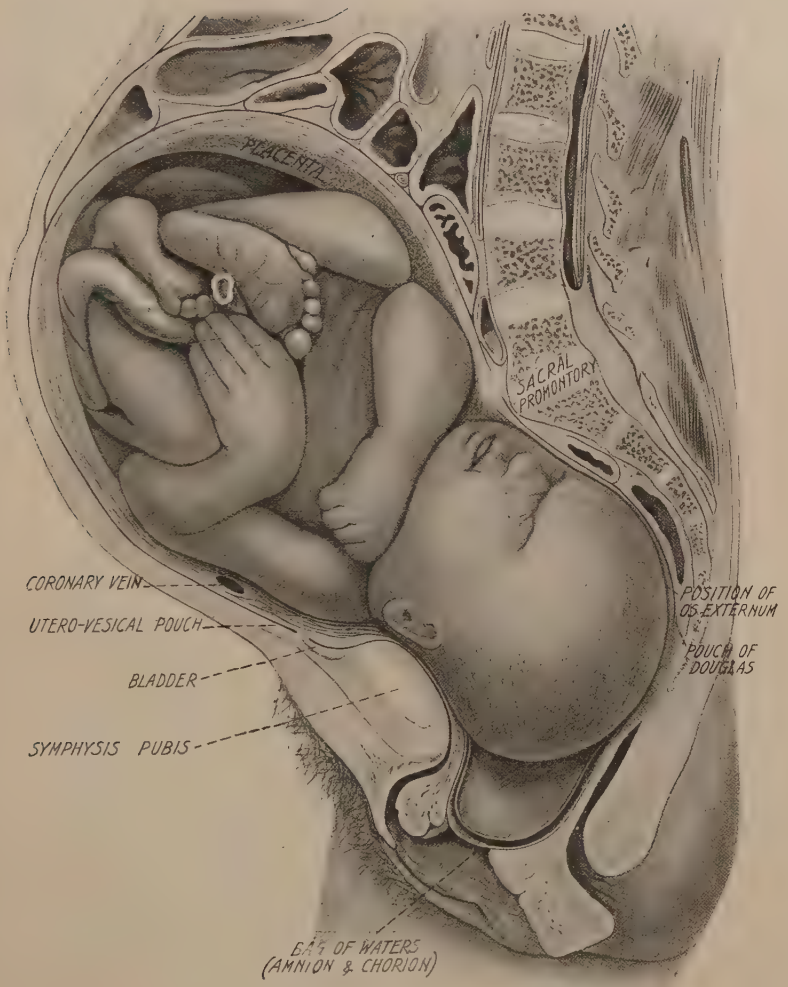


FIG. 114.—Section showing the Second Stage of Labour. The Os is fully dilated, and the unruptured Bag of Waters presents at the Vulva. The Uterus is thrown forwards away from the Spine, and no Sinuses are seen in the Uterine Wall, showing that death occurred during a contraction which passed into rigor mortis.[1] (Braune, from Barbour's Anatomy of Labour.)

[1] *Note.*—Flexion is deficient; the right arm lies under the chin; internal rotation is nearly complete.

until the second stage is considerably advanced ; in exceptional cases it may not occur at all, the bag protruding at the vulva

and the head being still enclosed in the membranes. As a rule, however, in such cases the chorion ruptures, allowing the

FIG. 115.—Section showing the End of the Second Stage of Labour. The Axis of the Uterus is parallel to the Spine, and the Sinuses in the Wall are open, showing that death occurred during relaxation.[1] (Chiara, from Barbour's Anatomy of Labour.)

[1] *Note.*—Flexion is deficient; the head lies in the transverse diameter.

amnion to protrude through it, and it is the latter membrane alone which presents at the vulva.

The duration of this stage is variable, being usually much

longer in a primipara than in a multipara. Its average may be stated as sixteen hours in the former, and eight hours in the latter. The patient suffers throughout from intermittent pain, felt chiefly in the abdomen, occurring at more or less regular intervals of from three to five minutes; frequently there is vomiting in this stage, but the pulse and temperature remain normal.

Second Stage, or Stage of Expulsion.—This stage begins at the time when dilatation of the cervix is complete, whether accom-

FIG. 116.—Birth of Head: Scalp appearing at Vulva. (Whitridge Williams.)

panied by rupture of the membranes or not; it ends with the complete expulsion of the fœtus from the birth-canal. The presenting part is now passing from the cervix into the vagina, and on examination the lip of the os externum cannot be felt posteriorly, but is still within reach anteriorly. It will be observed that during this stage the vagina becomes gradually dilated from above downwards (Fig. 114) by the passage through it of the head and body of the fœtus. The condition of the birth-canal towards the end of the second stage, but before the actual expulsion of the fœtus, is seen in Fig. 136, which shows

that the uterus, cervix, and vagina have been merged into a single broad channel, the boundaries between the component parts having been obliterated.

The expulsion of the child is accomplished by the uterus, strongly reinforced by the voluntary muscles, which are vigorously used by the patient. The participation of the voluntary muscles is the chief factor in causing the characteristic feature of the pains of the second stage. The onset of each pain is accompanied by a deep inspiration, followed by straining or

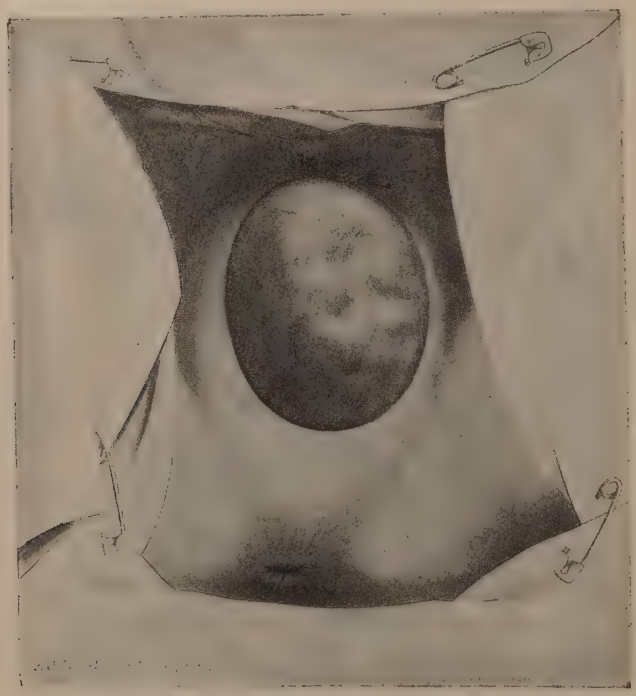


FIG. 117.—Birth of Head : Vulva completely dilated. (Whitridge Williams.)

'bearing down,' in which the patient holds her breath and employs her diaphragm, abdominal and back muscles, and sometimes apparently all the muscles in her body. The face becomes congested, the pulse quickened ; she perspires a little and groans deeply during the pains. They last much longer and recur more frequently than those of the first stage.

When the head reaches the pelvic floor, the first change observed in the external genitals is stretching of the perineal body, which during the pains becomes somewhat convex externally and lengthened from anus to vulva (Fig. 116).

Next the anus becomes turgid and dilates slightly, and the hairy scalp appears at the vulva (Fig. 117). As each pain passes off, the parts resume their normal appearance. When the head is about to emerge the anus gapes widely, exposing one to two inches of the anterior rectal wall. The fourchette becomes greatly thinned as the vulva stretches, and a certain amount of laceration of the posterior wall of the ostium vaginæ may be expected to occur. This laceration usually also extends to the lower part of the posterior vaginal wall and at times to the perineal body, which may in some instances be torn up to or including the anus. The actual expulsion of the head in a primipara is accomplished by a very prolonged and severe contraction, or by a series of powerful contractions, accompanied by violent straining.

A short pause then occurs, to be succeeded in two or three minutes by a return of the pains, which expel first the shoulders and then the trunk and lower extremities. In the case of a large fœtus, the expulsion of the shoulders may cause as much laceration of the vulva as the delivery of the head. As the body escapes a rush of blood-stained liquor amnii follows, representing the portion of fluid which has been retained in the uterus along with the trunk and limbs. The second stage lasts on an average two hours in a primipara ; in a multipara it is often very short, lasting only ten to fifteen minutes when the uterus acts powerfully ; but it may last very much longer than this when the pains are relatively feeble.

Third Stage, or Delivery of the After-birth.—The after-birth consists of the placenta, umbilical cord, and membranes ; the latter include the amnion, chorion, and sometimes the remains of the decidua vera.

Following upon the expulsion of the fœtus, the uterus undergoes a sudden and striking diminution in size. The fundus now lies about the level of the umbilicus, and the uterus appears to be about as large as the fœtal head. It will be observed to vary gradually in consistence, becoming alternately harder and softer to the touch ; this signifies that intermittent contractions are continuing, but they are almost painless, and the patient is usually unconscious of them. After a period varying on an average from ten to thirty minutes, certain changes occur which indicate that the placenta has been detached from the uterine wall and driven into the lower uterine segment and cervix, or into the vagina. The uterus becomes smaller, harder, more globular in shape, and more freely movable from side to side ; the level of the fundus, which is hard and retracted, rises, while the lower segment, now plainly felt above the pubes, is soft and bulging from the presence in it of the placenta. It may also be noticed that the length of the umbilical cord lying outside the vulva is greater than before. A certain amount of

hæmorrhage always accompanies the process of separation of the placenta. Expulsion is usually accomplished by a voluntary effort on the part of the patient, when the placenta appears at the vulva, and can be withdrawn by the attendant; a considerable amount of blood-clot often follows it.

The uterus is now about the size of a cricket-ball, and should remain almost uniformly firm and hard; but for some hours after labour intermittent spontaneous contraction and relaxation can usually be recognised.

The Anatomy and Physiology of the First and Second Stages of Labour

In this section will be described (I.) the maternal passages and the effects of labour upon them; (II.) the fœtus at term

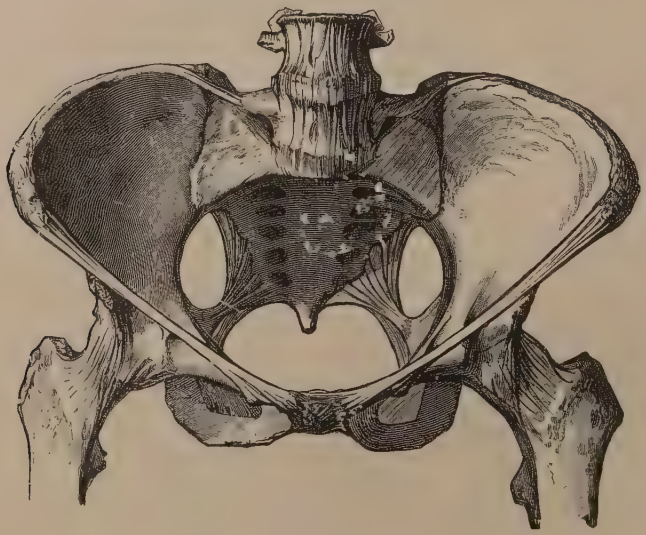


Fig. 118.—Female Pelvis.

and the effects of labour upon it; (III.) the forces of labour, their mode of action, and their influence upon the general physiological functions of the mother.

I. **The Maternal Passages.**—These comprise the bony canal with the soft structures which line it and close in its outlet.

A description of the general anatomy of the pelvis is unnecessary in a text-book of midwifery; it will, however, be useful to recall the points of difference between the male and female pelvis (Figs. 118 and 119). In the female the bones are more slender and the muscular impressions less pronounced. The false pelvis (the part above the pelvic brim, and bounded

laterally by the iliac bones) is more capacious in the female than in the male, the anterior superior iliac spines being a little further apart, and the iliac fossæ looking more directly forwards. In the female the true pelvis is more capacious, though a little shallower ; the sacral promontory projects less into the brim ; the sacrum is less concave anteriorly ; the pelvic outlet is considerably larger in all its diameters, and the pubic arch forms a much more obtuse angle. Sometimes a female pelvis approximates to the male characteristics, leading to a certain amount of difficulty in labour.

With the *false* pelvis we have little concern except that its

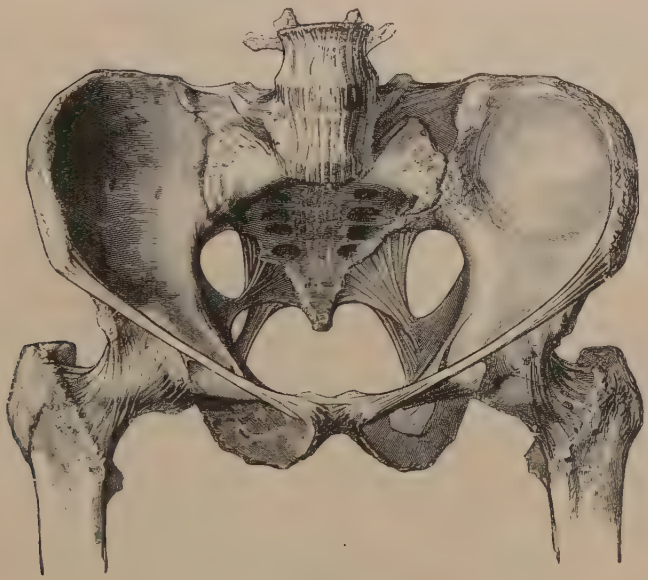


Fig. 119.—Male Pelvis.

dimensions are of service in indicating the shape and size of the true pelvis ; these will be mentioned in describing clinical pelvimetry (p. 370). The *true* pelvis is divided for systematic description into three parts—viz., the *brim*, the *outlet*, and the *cavity*.

The *pelvic brim* or *inlet*, or *upper pelvic strait*, is the plane of division between the false and the true pelvis (Fig. 120). It may be traced from the centre of the upper border of the symphysis pubis (*b*), along the pubic crest, past the pubic spine to the ilio-pectineal eminence (*f*), thence along the iliac portion of the ilio-pectineal line to the sacro-iliac synchondrosis (*g*), thence along the ala of the sacrum to the centre of the sacral promontory (*a*). Its shape is that of a transverse oval, with a

slight posterior constriction caused by the promontory of the sacrum (Fig. 125). We have to consider its *plane*, its *inclination*, its *axis*, and its *diameters*. The *plane* of the pelvic brim is an imaginary flat surface bounded by the limits just mentioned as those of the brim ; it is convenient to speak of the presenting part of the fœtus as lying above, or below, or in the plane of the brim. The plane of the brim is not, in the erect position of the body, a horizontal surface, but, owing to the oblique articulation of the pelvis with the femora, it is inclined at an acute angle to the horizon ; this is its *inclination*. This will be clear from Fig. 121 (*a*), which represents a bisected pelvis, placed in the position

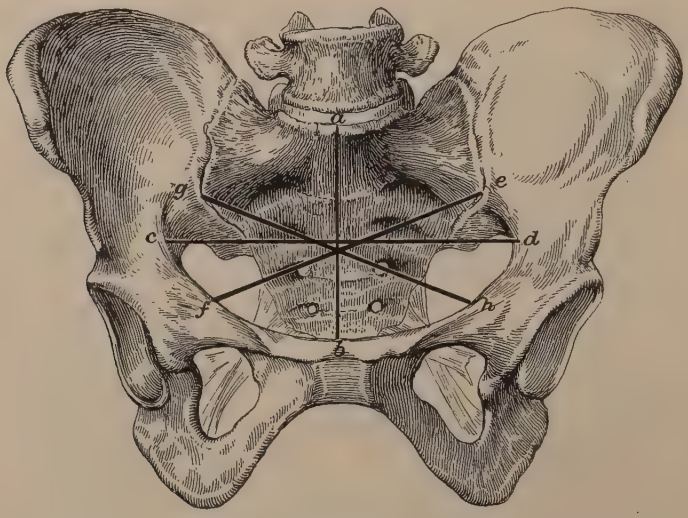


FIG. 120.—The Female Pelvis: Outline of Pelvic Brim, *a*, *e*, *d*, *h*, *b*, *f*, *c*, *g*.
a, *b*. Conjugate diameter. *c*, *d*. Transverse diameter. *e*, *f*. Left oblique diameter.
g, *h*. Right oblique diameter.

it would occupy in the erect attitude. The general inclination of the line of the brim is well seen. The same points are shown diagrammatically in Fig. 121 (*b*), which shows that the angle of inclination in the erect position is 55°. The posterior border of the brim accordingly stands at a higher level than the anterior, the sacral promontory being about $3\frac{3}{4}$ inches above the upper border of the symphysis pubis in the erect position. It must also be observed that the surface of the body of the pubes is not vertical, but almost at right angles to the plane of the brim. The *axis* of the brim will be represented by an imaginary straight line drawn perpendicular to the plane of the brim at its centre ; this being produced upwards and downwards, will pass from the umbilicus to the tip of the coccyx (Fig 123.).

This line indicates the direction in which a body passing through the pelvic brim must travel. Four *diameters* of the pelvic brim are described; it must be recollected that they are skeletal measurements and represent averages from which slight variations in both directions occur. The antero-posterior diameter or *conjugate* is measured from the centre of the sacral promontory behind to the nearest point in the middle line upon the posterior surface of the symphysis pubis in front (Fig. 120, *a*, *b*). This diameter is also called the *obstetric* or *true conjugate*,

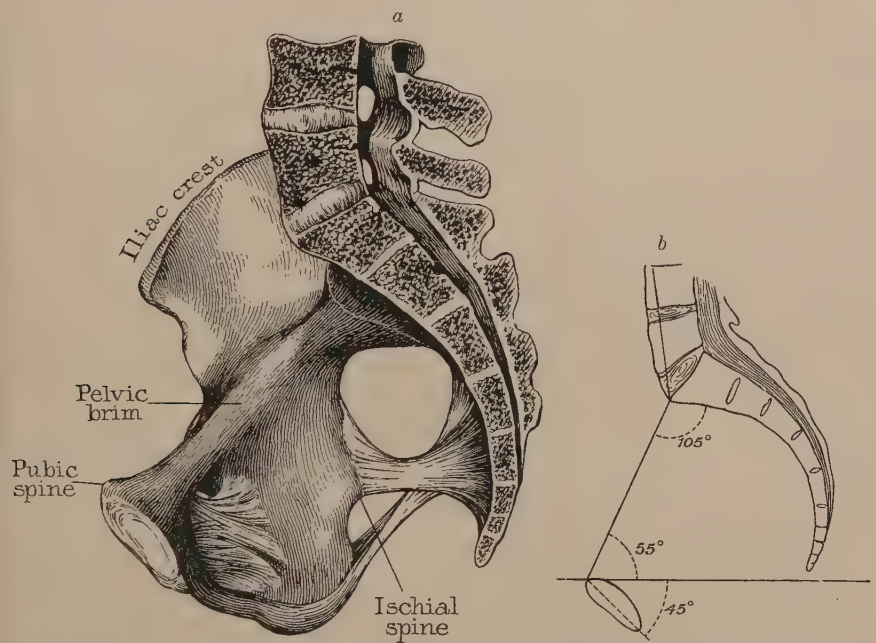


FIG. 121.—*a*. A Bisected Pelvis, as in the Erect Position, showing the Inclination of the Pelvic Brim. *b*. The same represented diagrammatically.

to distinguish it from certain clinical measurements to be afterwards described, which are also called conjugates. The two *oblique* diameters are measured from the sacro-iliac synchondrosis behind to the ilio-pectineal eminence on the opposite side; the right oblique is that taken from the right sacro-iliac joint (*g*, *h*), the left from the left sacro-iliac joint (*e*, *f*). A *transverse* diameter is also described, being the distance between the two furthest apart points of the pelvic brim (*c*, *d*); this line lies nearer the sacrum than the pubes, and is not, strictly speaking, a *diameter* at all, since it does not pass through the centre.

The *pelvic outlet* or *lower pelvic strait* is the lowest portion of

the pelvis, and forms a shallow segment of the pelvic cavity which is bounded above by what is known as the *narrow pelvic plane* and below by the *anatomical outlet* of the pelvis. Thus, the *obstetrical outlet* must be clearly distinguished from the *anatomical outlet*. The *anatomical outlet* is a lozenge-shaped space bounded in front by the lower border of the symphysis pubis; laterally by the pubic arch, the ischial tuberosities, and the greater and lesser sacro-sciatic ligaments; posteriorly by the coccyx (Fig. 122). These boundaries do not lie in a single

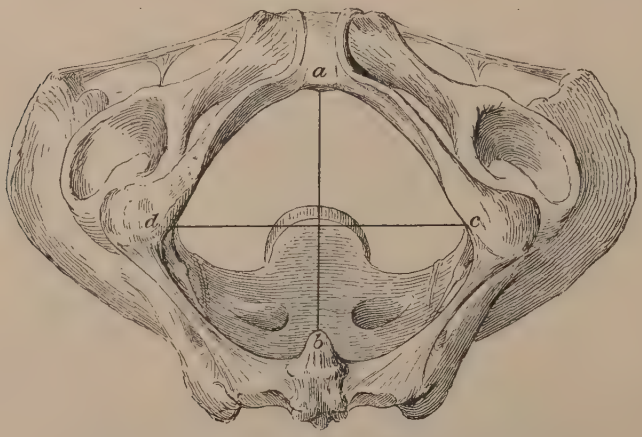


FIG. 122.—The Anatomical Outlet of the Pelvis.
a, b. Antero-posterior diameter. *c, d.* Transverse Diameter.

plane, but in two triangular planes the common base of which is the line joining the ischial tuberosities and with apices respectively at the pubic arch and the tip of the sacrum. The *narrow pelvic plane* is the imaginary flat surface bounded in front by the lower border of the symphysis, laterally by the tips of the ischial spines, and posteriorly by the lower border of the last sacral vertebra; as thus defined, its shape is that of an antero-posterior oval (Fig. 125). The *narrow pelvic plane* is the plane of least pelvic dimensions, and the distance between the ischial spines is the shortest diameter of the normal pelvis (10·5 cm.); it represents the *plane of the outlet* and there is general agreement to refer to it as such. Its *axis* will be represented by a line joining the centre of its plane with the sacral promontory —a line much more nearly vertical than the axis of the brim (Fig. 123). Besides representing the plane of the outlet, the *narrow pelvic plane* is a useful landmark for other reasons—(1) it marks the beginning of the forward curve of the pelvic axis; (2) it corresponds to the site of origin of the levator ani muscles; (3) the ischial spines are easily felt on vaginal examination and

an imaginary line drawn between them is useful for determining the degree of descent of the fœtal head into the pelvis ; if the head has reached this line it is certain it has engaged in the pelvic brim.

As thus defined the *obstetrical outlet* is to be regarded as a shallow segment of the pelvic cavity with anterior, lateral and posterior walls. Its anterior wall is defective at the pubic arch ; its important lateral walls include the greater part of the ischial bones and its posterior wall includes the tip of the sacrum and the coccyx (Fig. 124). Only three diameters can be described : the *antero-posterior*, taken from the centre of the lower border of

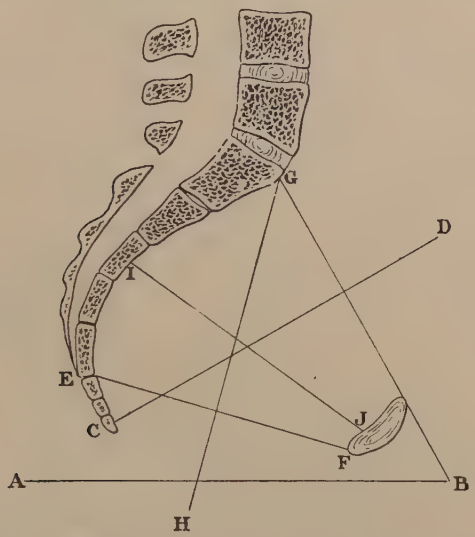


FIG. 123.—The Planes and Axes of the Normal Pelvis.

A, B. Horizonal line. G, B. Plane of the brim. J, I. Plane of the mid-cavity. F, E. Plane of the outlet. D, C. Axis of the brim. G, H. Axis of the outlet.

the symphysis to the tip of the last sacral vertebra (Fig. 122) ; the *transverse* of the narrow pelvic plane, between the ischial spines ; and the *transverse* of the anatomical outlet, between the inner borders of the ischial tuberosities (Fig. 122). Oblique diameters cannot be defined, as between the ischial tuberosities and the coccygeal border the pelvic outlet is filled in with soft structures only, and the diameters we are considering are skeletal.

It will be obvious that the length of antero-posterior diameter is reduced by the forward projection of the coccyx in the skeleton. During labour, however, the movement of the coccyx at the sacro-coccygeal joint carries it backwards, so that the length of the diameter is not much affected. When the sacro-

coccygeal joint is ankylosed this movement cannot occur, and the available diameter is reduced.

The *pelvic cavity* is the space between the plane of the brim above and the plane of the outlet (the narrow pelvic plane) below. It forms a curved canal with a shallow anterior and a deep posterior wall, the former measuring $1\frac{1}{2}$ inches, the latter

FIG. 124.—The Obstetrical Outlet or Lower Pelvic Strait.

The heavily shaded part is bounded above by the 'narrow pelvic plane' (plane of the outlet) and represents the bony extent of the obstetrical outlet.

$4\frac{1}{2}$ inches; its lateral walls are about 4 inches deep. It is obvious that a number of *planes* of the cavity, taken at different levels, might be described, but it suffices to determine a single one—the *mid-plane*, bounded in front by the centre of the symphysis pubis, and behind by the junction of the second and third sacral vertebræ. It is the plane of widest pelvic dimensions, and represents the roomiest part of the pelvic cavity. Its shape is intermediate between that of the brim and that of the outlet

(Fig. 125). Its *antero-posterior diameter* is measured from the points just mentioned, its *transverse diameter* across the widest part; *oblique diameters* cannot be precisely defined, owing to the soft structures filling in the sacro-sciatic notches. The *axis* of the mid-plane of the cavity is represented by a line, the direction of which is intermediate between those of the brim and the outlet. By uniting the axes of the three planes of the brim, mid-cavity, and outlet, a line is formed which will traverse the centre of the canal of the bony pelvis. It forms a curve, concave anteriorly, and directed at first downwards and backwards (axis of brim), then gradually more and more forwards until it reaches the axis of the outlet. This line is known as the *anatomical axis of the pelvis* or curve of Carus. But as the pelvic cavity is almost cylindrical in shape in its upper three-fourths, it is apparent that

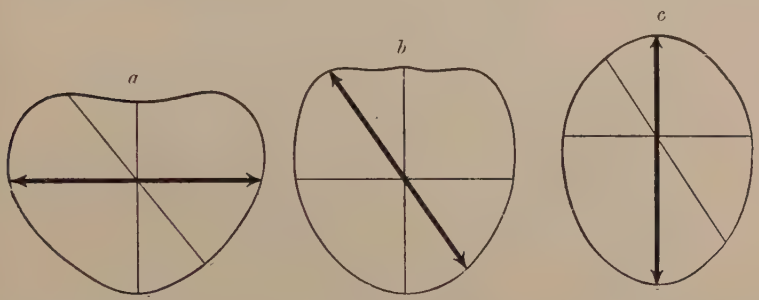


FIG. 125.—The Planes (*a*) of the Brim, (*b*) of the Cavity, (*c*) of the Outlet.
The double-headed arrow represents the longest diameter.

the head must descend in the axis of the pelvic inlet until near the level of the ischial spines and only begins to curve forward near the plane of the pelvic outlet. Therefore the *obstetrical pelvic axis*, which represents the true path of the head through the pelvis, should be represented by a line which is straight in its upper and curved only in its lower portion (Fig. 126).

The average length of the diameters of the bony pelvis is as follows:

	Ant.-post.	Oblique.	Transverse.
Brim (plane) . .	4¼ in. (11 cm.)	4¾ in. (12 cm.)	5¼ in. (13 cm.)
Cavity (mid-plane).	4¾ ,, (12 ,,)	5 ,, (12·5 ,,)	4¾ ,, (12 ,,)
Outlet (plane) .	5¼ ,, (13 ,,)	4½ ,, (11·5 ,,)	4¼ ,, (10·5 ,,)

The transverse diameter of the anatomical outlet, measured between the inner borders of the ischial tuberosities, is 11 cm., being rather greater than the distance between the ischial spines. The oblique diameters of the cavity and outlet are approximate, for the reasons already mentioned. The antero-posterior diameter of the outlet is clinically measured from the lower

border of the symphysis to the tip of the coccyx instead of to the lower border of the last sacral vertebra. With the coccyx pushed back to the fullest possible extent in the position it assumes in normal labour when the fœtal head passes through it measures $5\frac{1}{4}$ inches ; with the coccyx in its normal position it is $\frac{3}{4}$ to 1 inch less than this.

These diameters are reduced by the soft structures which line the pelvic walls and by the viscera contained within the

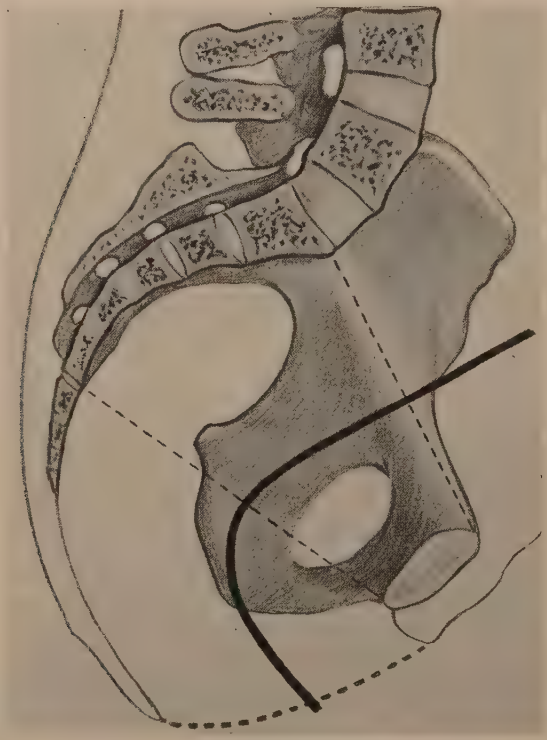


Fig. 126.—The Obstetrical Pelvic Axis.

pelvis. The ilio-psoas and obturator internus muscles reduce the transverse and oblique diameters at the brim. The pelvic colon and upper part of the rectum lie in the left oblique diameter both of the brim and the cavity ; in parturient women the conjugate of the brim passes through the urethra and through both walls of the cervix, which diminish the space available for the accommodation of the presenting part of the fœtus. Frozen sections show that in the second stage the available space in the conjugate diameter is thus diminished, at the brim from $\frac{1}{4}$ to $\frac{1}{2}$ inch, in the cavity from $\frac{1}{2}$ to $\frac{3}{4}$ inch.

The *pelvic floor* comprises the soft parts which fill in the pelvic outlet. For a general description of the structures of which it is composed a text-book on anatomy should be consulted; we are only concerned with the changes which it undergoes during labour.

Under ordinary conditions the outer or lower surface of the pelvic floor (the anatomical *perineum*) is somewhat convex, the centre of the perineal body being $1\frac{1}{4}$ inches below the level of a line joining the lower border of the symphysis with the tip of the coccyx. The usual *projection* of the pelvic floor is, therefore, $1\frac{1}{4}$ inches. Three canals pierce it—viz., the urethra, the vagina,

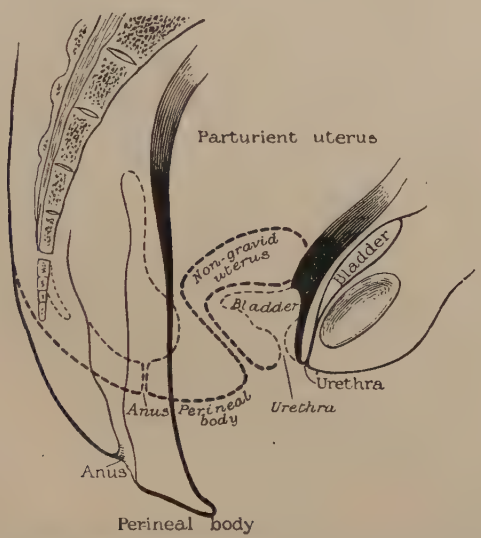


FIG. 127.—Schematic Representation of the Displacement of the Pelvic Floor in Labour. (Dakin.)

and the rectum (Fig. 127). The central canal, the vagina, becomes enormously dilated during the second stage of labour, and in consequence the whole disposition of the pelvic floor is altered (Fig. 127). The dilatation of the vagina divides the pelvic floor into two sections; the anterior section, lying in front of the vagina, becomes drawn upwards and forwards; the posterior section, lying behind it, becomes displaced downwards and backwards, and the fœtus is expelled through the space thus opened up between them. The process has been aptly likened by Berry Hart to the act of passing through swing doors by pulling one door towards you and pushing the other away. The upward displacement of the anterior section is indicated by the alteration which occurs in the position of the

urethra and bladder during the second stage of labour. During the first stage it remains a pelvic organ, and lies behind the symphysis pubis (Fig. 105); in the second stage it becomes drawn up above the pubes into the abdomen, while the urethra is correspondingly elongated (Fig. 128). The displacement of the posterior section has been described in connection with the clinical phenomena of the second stage of labour. The effects produced are diagrammatically shown in Fig. 127. The

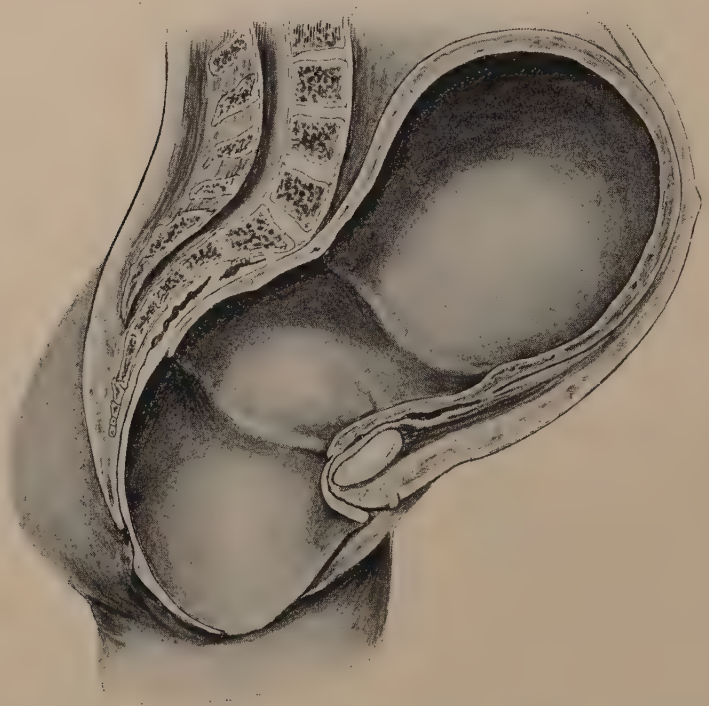


FIG. 128.—The Fully Dilated Parturient Canal. (Galabin and Blacker.)

fourchette is now the lowest part of the pelvic floor; it lies 4 inches below the coccygo-symphysial level; the *projection* of this portion of the pelvic floor has therefore been increased to 4 inches, and a wide aperture of exit provided for the fœtus. The effect of this displacement is to prolong the pelvic canal by the formation of a tube composed solely of soft parts below the level of the pelvic outlet; this prolongation, like the cavity of the true pelvis itself, has a shallow anterior wall, but deep posterior and lateral walls. Its relation to the bony canal is

diagrammatically shown in Fig. 126, from which it will be seen that the axis of the prolongation forms a continuation of the axis of the bony pelvis.

The most important of the structures which make up the pelvic floor are the pelvic fascia and the levator ani muscle. The former is the visceral layer which springs from the fascia clothing the lateral pelvic wall at the level of the *white line* which corresponds to the level of the ischial spine. Attached to the lower surface of the pelvic fascia and arising from it are the fibres of the levator ani. These two structures form

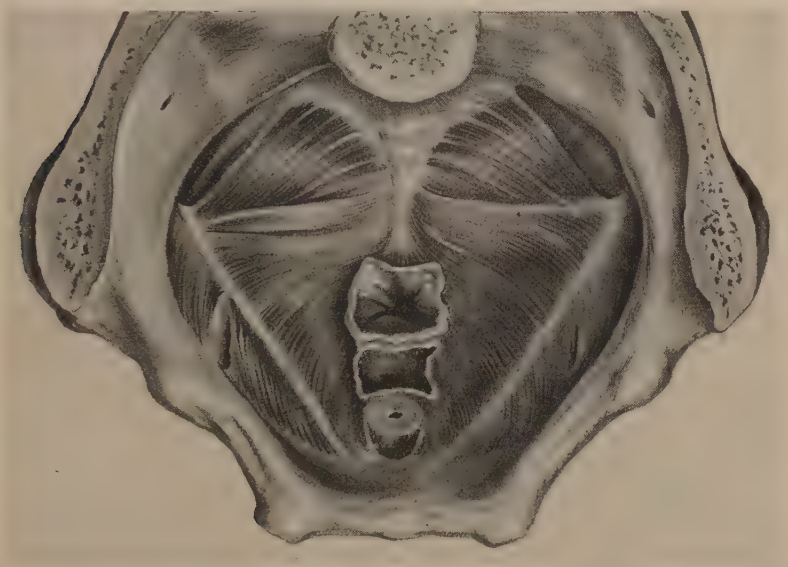


Fig. 129.—The Pelvic Diaphragm, formed by the Levator Ani Muscles, seen from above; it is pierced, from before backwards, by the urethra, vagina and rectum.

a diaphragm closing in the pelvic cavity below, inasmuch as from each side they pass downwards and inwards towards the mesial plane, where they meet and where they are pierced by three canals: the rectum, the vagina, and the urethra. (Fig. 129). Owing to the inclination of the pelvis, the whole pelvic floor (but especially the posterior section) also slopes somewhat forwards; therefore the fœtal head, when it reaches the pelvic floor, rests upon a sloping, not a horizontal, surface, the general direction of the slope being downwards, forwards, and inwards.

The effect of the changes which occur in the pelvic floor during the second stage is greatly to stretch and often to injure the

anterior fibres of the levator ani muscle and the portion of the pelvic fascia to which it is attached. These fibres arise from the posterior surface of the symphysis pubis, and passing downwards and backwards, ensheath the walls of the vagina. The great dilatation which the vaginal canal undergoes, and the extent to which its posterior wall becomes elongated, during the

FIG. 130.—Fœtus showing the Normal Attitude of Flexion. (Barbour.)

passage of the child through it, necessarily inflicts a certain amount of injury upon the muscular fibres, and in some instances upon the fascia also. This results later on in prolapse of the vaginal walls and of the uterus itself.

II. **The Fœtus.**—Under this heading we have to consider (1) the disposition of the fœtus *in utero;* (2) the size and characters of the fœtal skull; and (3) the protective action of the bag of fluid in which the fœtus is contained.

(1) *The Disposition of the Fœtus.*—During the last weeks of pregnancy the head, trunk, and limbs of the fœtus are packed up into the smallest possible space in a regular and fairly constant arrangement, which is termed the fœtal *attitude.* This is

Fig. 131.—Fœtus showing Deficient Flexion of the Head through the Arms being underneath the Chin. (Barbour.)

best described as an attitude of general flexion (Fig. 130), and the study of frozen sections has entirely removed this point from the field of speculation. The head is flexed so that the chin touches the anterior chest-wall ; the forearms are flexed and crossed more or less symmetrically, so that forearms and

hands cover the face (Fig. 130); the thighs are fully flexed on the abdomen, the legs on the thighs, the feet on the legs, the latter being generally crossed, but sometimes lying side by side; and, lastly, the spine is flexed, the back forming a distinctly convex surface. Slight departures from this arrangement may be met with. Thus the forearms may lie under the chin as in Fig. 131, thus rendering complete flexion of the head impossible. All abnormalities of attitude lead to a certain amount of difficulty in labour. Any disturbance of this attitude usually results in some departure from the normal course of labour.

As thus disposed, the body of the fœtus forms an ovoid mass the greatest width of which corresponds with the shoulders. The dimensions of the ovoid are as follows (Fig. 132):

Vertico-podalic diameter (V-P)	. .	9½ to 10 in. (24 to 25 cm.)
Bis-acromial ,, (A-A)	. .	4¾ ,, (12 cm.)
Bi-trochanteric ,, (T-T)	. .	4 ,, (10 ,,)

The widest transverse diameter is across the shoulders. The smallest circumference of the flexed head is about 11 inches (27·5 cm.); the circumference of the breech, both thighs being flexed, is about 13 inches (32·5 cm.).

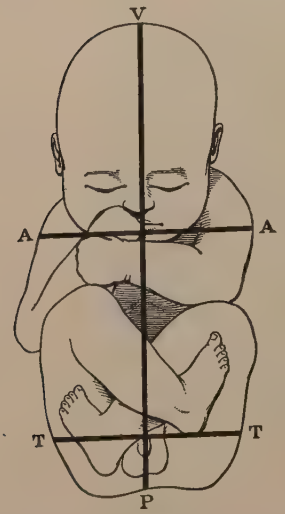


FIG. 132.—The Normal Attitude of Flexion (diagrammatic). (Dakin.)

From this it follows that the fœtal ovoid will adapt itself most easily to the ovoid shape of the uterine cavity at term when the head lies below and the breech above; the least convenient arrangement will be that in which the fœtal ovoid lies across the uterine ovoid. When the long axes of the fœtal and uterine ovoids correspond, the arrangement is called the *longitudinal lie;* of this there are two varieties—(*a*) that in which the head is below, and (*b*) that in which the breach is below. When the long axes do not correspond, the arrangement is called the *transverse* or *oblique lie.* In over 96 per cent. of all labours the lie is longitudinal with the head below; when this is the case the part of the head which first enters the pelvic brim is in the great majority of cases the *vertex.* This arrangement is called in brief a *vertex presentation*, the first part to enter the brim being always termed the *presenting part.* Presentation of the

vertex implies that the head is fairly well flexed, even if the chin does not actually rest on the chest.

(2) *The Fœtal Skull.*—Since the head presents in such a preponderating proportion of cases, it must be studied in detail and in relation to the parturient canal through which it has to pass.

The ossification of the fœtal skull at term is incomplete, especially that of the bones which compose the vault. While those of the base are firm and incompressible, the tabular bones of the vault remain thin and pliable, and are separated at their edges by intervals of unossified membrane forming the *sutures* and the *fontanelles*. The vault of the skull is consequently

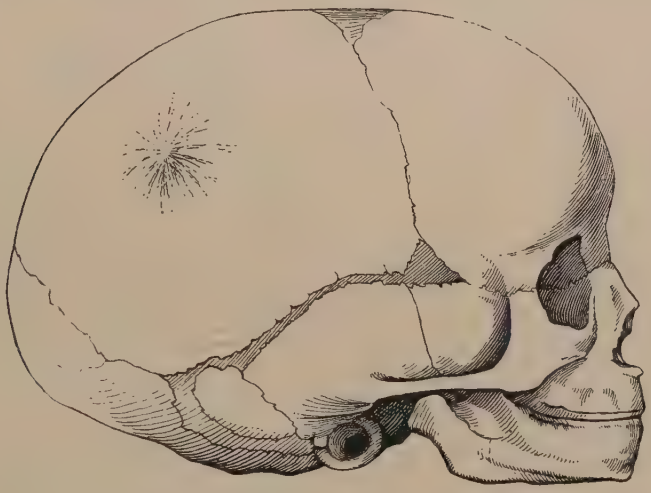


FIG. 133.—Side View of the Fœtal Skull.

plastic, and in fact it becomes modified considerably in shape by the pressure to which it is subjected during labour.

The *sagittal* suture crosses the vault of the skull in the middle line, lying between the two parietal bones (Fig. 134, *b*); in the same plane in front of the anterior fontanelle runs the *frontal* suture, lying between the two halves of the frontal bone. The *coronal* suture separates the frontal from the parietal bones, meeting the sagittal and frontal sutures at the anterior fontanelle (Fig. 134, *b*). The *lambdoidal* suture separates the parietal bones from the tabular portion of the occipital bone (Fig. 134, *a*).

Four or five fontanelles exist in the skull at term, but only two of them are of practical importance in midwifery—viz., the anterior and posterior fontanelles. The *anterior fontanelle* or *bregma* is an unequal-sided lozenge-shaped piece of unossified membrane, lying in the mesial plane between the two frontal

and the two parietal bones (Fig. 134, *b*). Its angles are continuous with the frontal, the sagittal, and the right and left halves of the coronal sutures. The latter enter it considerably behind its centre. It measures $1\frac{1}{4}$ inches in antero-posterior and $\frac{4}{5}$ inch in transverse diameter, and as it lies a little below the general level of the skull, it can be felt on the surface as a shallow depression. The *posterior fontanelle* is not as a rule an unossified piece of membrane at all, but a triangular depression produced by the angle of the tabular portion of the occipital bone being slightly depressed below the level of the posterior borders of the parietal bones with which it comes in contact (Fig. 134, *a*). This depression lies at the point of junction

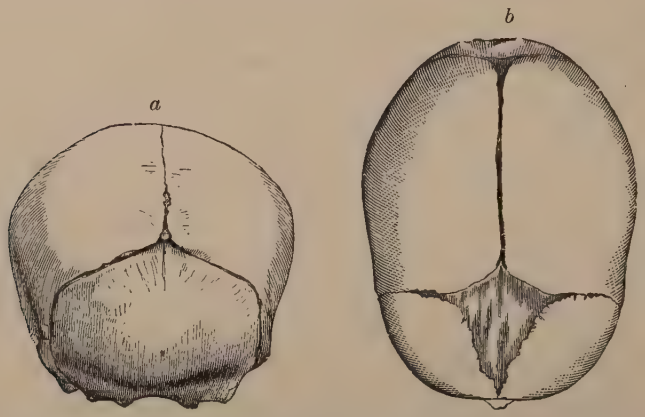


FIG. 134.—*a*, Fœtal Skull showing the Posterior Fontanelle. *b*, Fœtal Skull showing the Anterior Fontanelle. (Galabin.)

of the sagittal suture with the right and left halves of the lambdoidal suture. In a premature fœtus, however, an unossified piece of membrane often persists at the posterior fontanelle.

These two fontanelles are of importance because they can be recognised by touch during labour, and from them valuable information can be obtained as to the position and attitude of the fœtal head. The anterior can be recognised by its lozenge shape, its soft membranous floor, and the presence of four sutures running from its angles. The frontal suture, being wider than the sagittal suture, distinguishes the anterior end of the fontanelle. The posterior fontanelle is triangular in shape, has a hard floor, a raised edge (parietal), and is connected with only three sutures.

The *vertex* is the area of the vault of the skull which is bounded in front by the anterior fontanelle and coronal suture behind by

the posterior fontanelle and lambdoidal suture, and laterally by lines passing through the parietal eminences.

The general shape of the fœtal head is that of an ovoid with a long antero-posterior diameter (Fig. 133). In the normal attitude of complete flexion the long diameter of the head ovoid forms a very acute angle with that of the body ovoid; when the head lies midway between flexion and extension the two long diameters cross one another at right angles; when the head is fully extended the angle formed is very obtuse and the face becomes the lowest part. This part of the circumference of the head which first comes in contact with the pelvic brim—*i.e.*, the *girdle of contact*—varies with the degree of flexion or extension which may be present, and accordingly the diameter of the girdle of contact (*diameter of engagement*) also varies (Fig. 135). In passing from the position of complete flexion to that of complete extension the diameters of the successive girdles of contact are as follows:

	Length.	Presentation.
1. Sub-occipito-bregmatic (S.-o.-b.) (nape of neck to centre of bregma)	$3\frac{3}{4}$ in. (9·50 cm.)	Completely flexed vertex
2. Sub-occipito-frontal (S.-o.-f.) (nape of neck to anterior end of bregma)	4 in. (10·00 cm.)	Incompletely flexed vertex
3. Occipito-frontal (O.-f.) (occipital protuberance to root of nose)	$4\frac{1}{2}$ in. (11·25 cm.)	Extended vertex
4. Mento-vertical (M.-v.) (point of chin to centre of sagittal suture)	$5\frac{1}{2}$ in. (13·75 cm.)	Brow presentation
5. Sub-mento-vertical (S.-m.-v.) (angle between neck and chin to centre of sagittal suture)	$4\frac{1}{2}$ in. (11·25 cm.)	Incompletely extended face
6. Sub-mento-bregmatic (S.-m.-b.) (angle between neck and chin to centre of bregma)	$3\frac{3}{4}$ in. (9·50 cm.)	Completely extended face

In addition to the above, three transverse diameters of the head are of importance: (1) the *bi-parietal* ($3\frac{3}{4}$ inches—9·50 cm.), between the two parietal eminences; (3) the *bi-temporal* ($3\frac{1}{4}$ inches—8 cm.), between the anterior ends of the coronal suture; (3) the *bi-mastoid* (3 inches—7·5 cm.), between the tips of the mastoid processes. The circumference of the head varies in different planes; the smallest circumference is that of the sub-occipito-bregmatic plane, which measures 11 inches.

It must be recollected that the vault is compressible, and that all its diameters can be reduced in length to an appreciable extent during the passage of the head through the pelvis.

(3) *The Liquor Amnii.*—During the greater part of the

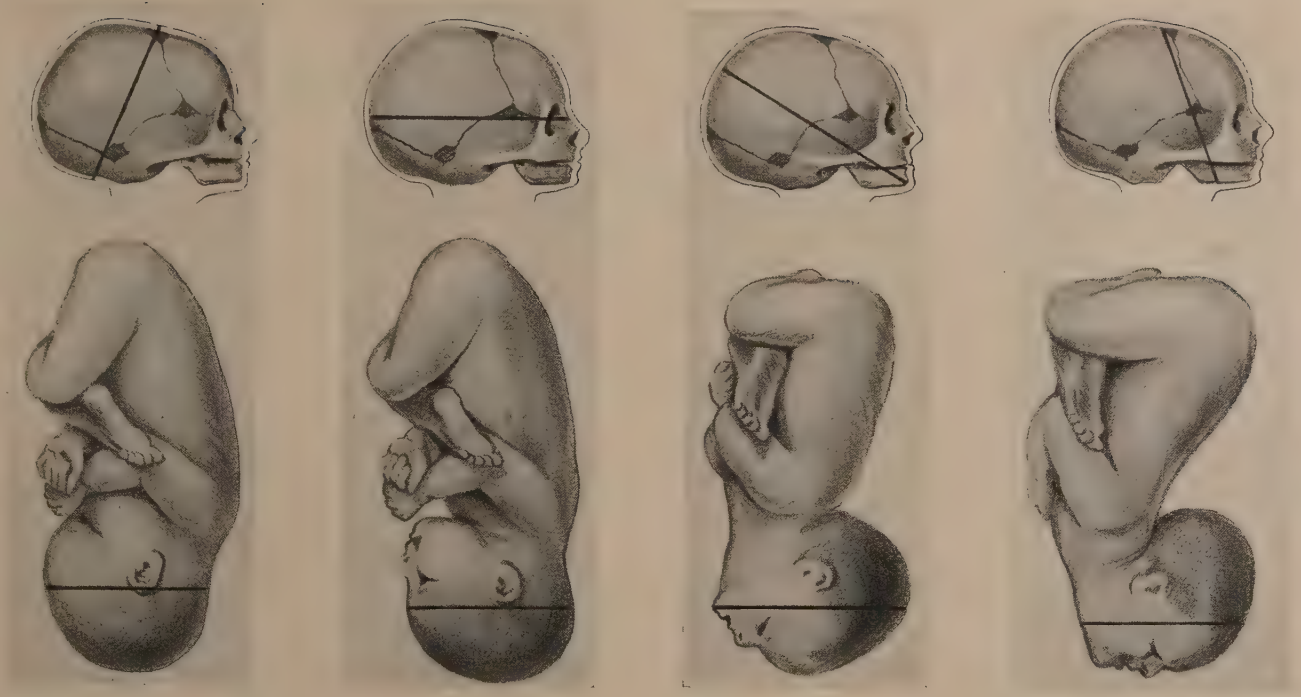


FIG. 135.—Varying Attitudes of Fœtal Head, with Diameters of Engagement.

(*a*) Completely flexed vertex : engagement of sub-occipito-bregmatic diameter.
(*b*) Extended vertex : engagement of occipito-frontal diameter.
(*c*) Brow presentation : engagement of mento-vertical diameter.
(*d*) Completely extended face : engagement of submento-bregmatic diameter.

process of labour the fœtus is protected from pressure by the liquor amnii at every part except the girdle of contact. The uterine contractions do not act directly upon the body of the fœtus until labour is far advanced and the liquor amnii has more or less completely escaped. The lower pole of the fœtal envelope containing the fore-waters becomes detached from the lower uterine segment early in labour, and is driven down by the contractions into the cervix in advance of the presenting part of the fœtus. The mechanical value of this *bag of waters* as an aid to the dilatation of the cervix is very considerable, on account of its elasticity and its shape. When the cervix is dilated and the bag of waters is consequently unsupported, the membranes, as a rule, can no longer resist the increased tension produced by the uterine contractions, and accordingly rupture. The membranes may, however, in some cases, rupture before labour or early in the first stage ; on the other hand, when unusually strong, spontaneous rupture may not take place at all, the bag of waters appearing at the vulva during the birth of the head.

In normal conditions the liquor amnii is sterile ; it may, however, become infected during labour by bacteria introduced from without, or by organisms which reach it through the placenta from the maternal circulation, as in certain acute infectious fevers. The former is, of course, greatly facilitated if ante-partum rupture of the membranes should occur, although we also know, from clinical observation, that bacterial infection may take place through intact membranes. The liquor amnii may also be fouled by meconium passed *in utero* in conditions producing fœtal distress.

III. **The Forces of Labour.**—The propelling force consists of muscular contractions, aided possibly to an insignificant extent by gravity and by the elastic recoil of certain portions of the birth-canal. The most important muscle is the uterus ; subsidiary to it are the diaphragm and the muscles of the abdominal wall ; those of the arms, legs, and back lend a certain amount of assistance in the expulsive stages.

The Parturient Uterus.—The changes which the uterine muscle undergoes during pregnancy have been already described. At term the wall of the uterus is about $\frac{1}{3}$ inch in thickness, and the organ measures $11\frac{1}{2}$ to 12 inches (29 to 30 cm.) in length from os externum to fundus (cervix $1\frac{1}{4}$ to 2 inches (3·5 to 5 cm.)); the diameters of the fundus itself are about 8 to 9 inches (20 to 22·5 cm.) transversely and 6 inches (15 cm.) antero-posteriorly. At the lower uterine segment the diameters are less, so that the organ is distinctly pyriform or ovoid in shape. The internal os is usually closed and the cervical canal intact when labour sets in (Fig. 104). The parturient uterus acts by intermittent contractions which have the effect, first, of dilating the lower

uterine segment and cervix, and, secondly, of expelling the uterine contents. The organ becomes differentiated during labour into an upper active and a lower passive section; this is probably an essential step in the process of parturition, and invariably precedes the actual expulsion of the fœtus.

The uterine contractions of labour are to be regarded as a development of the slight intermittent contractions which can be recognised clinically in the gravid uterus during the second half of pregnancy. During pregnancy the patient is unconscious of their presence, and they produce no effect upon either the cervix or the ovum; when labour begins they change their characters and become painful. Throughout the process they preserve their intermittent character, but the intervals tend gradually to diminish as labour advances, until the actual expulsion of the child through the vulva may be accomplished by a storm of powerful contractions separated by only slight intervals. After this their intensity suddenly falls, and the last part of the process—viz., the separation and expulsion of the after-birth—is accompanied only by a few comparatively feeble contractions. The uterine contractions are of course involuntary; in animals they are peristaltic, but clinically this is not observable in women. It may be surmised that the driving force of the uterus resides chiefly in the longitudinal fibres, contraction of which will tend to approximate fundus to cervix. Attempts have been made to measure the force exerted by the contractions by inserting into the uterus a rubber bag connected with a mercury manometer; Schatz found that the pressure rose to a height of from 80 to 250 mm. of mercury during the contractions, varying with the stage of labour, representing a force of $8\frac{1}{2}$ to $27\frac{1}{2}$ lbs.

With each contraction a change in the shape and position of the uterus occurs. When at rest the organ lies moulded upon the vertebral column (Fig. 50); during the contraction the fundus is thrown forward towards the abdominal wall, and the whole organ becomes rigid and erect. The effect of this change of position will be to make the long axis of the uterus correspond more closely with the line of the axis of the pelvic brim (Fig. 114).

As labour advances two other important changes are brought about in the parturient uterus—viz., (1) *dilatation* of the lower uterine segment and cervix; (2) *retraction* of the uterine wall above this level. The exact nature of these changes has been the subject of acute controversy since the study of the anatomy of labour by frozen sections began, and even now unanimity of opinion has not been reached.

(1) *Lower Uterine Segment and Cervix.*—The condition of the cervical canal before labour begins has been already described; it measures from $1\frac{1}{4}$ to 2 inches (3 to 5 cm.) from os externum

to os internum, and the lower uterine segment, corresponding to about the lower one-fourth of the total uterine cavity (Barbour), has the shape of a hemisphere. It will also be recollected that the uterine wall is thinner in the lower segment than elsewhere. The lower uterine segment is therefore the weakest part of the uterus and is the least resistant to the rise of intra-uterine pressure which results from the uterine contractions during the first stage of labour (see p. 251). In

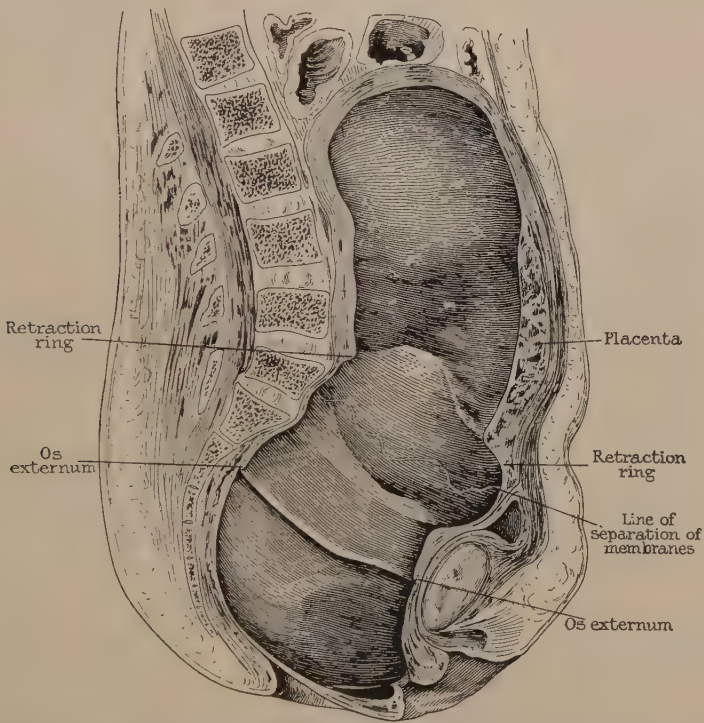


FIG. 136.—The Birth-Canal towards the end of the Second Stage of Normal Labour. (Barbour.)

consequence, an early effect of the uterine contractions is the expansion and further thinning of the lower segment. During the first stage of labour two zones of the uterus can usually be differentiated by abdominal palpation during a contraction, the upper being firm and hard, the lower giving a semifluctuant sensation ; the upper zone is the upper active three-fourths of the uterus, the lower is the passive lower segment.

The condition of these parts at the end of the second stage of labour is shown in Fig. 136. The lower segment has now been converted from a hemisphere into a cylinder, and forms with

the dilated cervix a single wide canal. The position of the os internum is very difficult to determine except by recognition of the upper limit of the characteristic cervical mucous membrane. But the conclusions arrived at by different observers upon this point are very divergent, and it appears probable that the proportion of the dilated part which corresponds to the cervix is variable. At the upper limit of this dilated part an abrupt change in the thickness of the uterine wall takes place, producing a raised ridge on the inner wall in the form of an irregular ring which varies a little in level in different parts. This ring is variously known as the *retraction ring* (Barbour), the *contraction ring* (Schroeder), *Bandl's ring*, etc. By some observers this ring was regarded as representing the internal os, the whole of the dilated part below it was considered to be cervix, and the existence of a lower uterine segment, distinct from the cervix, was denied. The work of Schroeder, Barbour, and Von Franqué, however, based on the study of frozen sections through women dying during the second stage of labour, appeared until recently to have satisfied most observers that the upper portion of the dilated part comes from the uterine body, not from the cervix. But this view has now again been challenged by Bumm and Blumreich, so that it is evident that controversy upon this matter is not yet over.

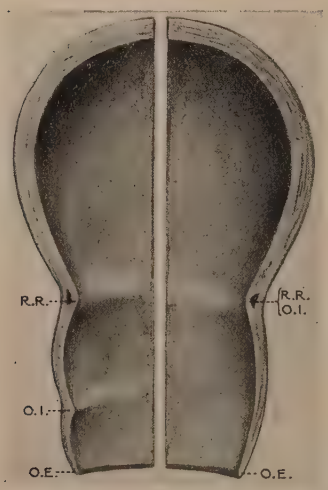


FIG. 137.—Diagram showing the two views on the formation of the lower uterine segment.

O.E., os externum: O.I., os internum; R.R., retraction ring.

In Fig. 137 are shown diagrammatically the two views as to the nature of the lower uterine segment. The matter would appear capable of being settled by histological examination of the tissues below the retraction ring. If the lower segment consists entirely of cervix, it should be lined throughout by cervical mucous-membrane; if it consists partly of uterine body its upper part should be lined by decidua. But the histological method has not proved satisfactory, because the finer surface details have been largely destroyed partly by stretching and pressure, and partly by the freezing process to which most of the available specimens have been subjected before microscopical examination.

The wall of the lower segment and cervix measures on an

average one-tenth of an inch (25 mm.) in thickness, while above the lower segment the uterine wall varies from one-half to a quarter of an inch (1·25 to 0·62 cm.) in thickness, being least at the placental site. Lower segment and cervix together now measure in length 3½ inches (9 cm.) on the anterior and 2½ inches (6·5 cm.) on the posterior wall. From examination of a number of frozen sections it appears that the average length of the uterus from fundus to os externum is 10 to 10½ inches (25 to 26 cm.) towards the end of the second stage of labour—*i.e.*, before the expulsion of the fœtus. The total length of the uterus has therefore at this period been reduced by about 1½ inches (4 cm.). The diameter of both lower segment and cervix is now about 4 inches (10 cm.). The *posterior vaginal wall* is greatly elongated—7 inches (18 cm.) in Fig. 136—and somewhat thinned, while the anterior wall is almost unaltered in length.

(2) *The Retracting Uterine Wall.*—The line of abrupt transition from the lower segment to the uterine body above it represents the line of physiological differentiation of the uterus into an upper active and a lower passive zone. The uterine contractions occur in the active portion only, the *rôle* of the other being entirely passive, as is shown by the marked degree of dilatation and thinning which it has undergone. The reduction in length of the active portion and the increased thickness of its walls represent, however, another phase of its activity—viz., *retraction.* The distinction between contraction and retraction of muscle is simple : contraction is a temporary reduction in length of the muscle, which may be succeeded by complete elongation to its original length ; but retraction signifies permanent shortening, complete elongation being impossible so long as the retraction lasts. In the case of a muscle contracting intermittently, a certain amount of retraction may accompany each contraction, unless, when the contraction passes off, it is again elongated to the full extent. Shortening from retraction will thus become progressive. This is what occurs in the uterus during labour : as the fœtus is driven with each contraction lower down into the pelvis, a certain amount of the advance is made good by retraction. If retraction did not occur, then the elastic recoil of the soft structures composing the walls of the undilated parts of the canal would act through the lower pole of the ovum upon the uterine muscle and completely elongate it, so that the fœtus would return to the position it occupied before the contraction occurred. Advance under such circumstances would of course be much delayed. Retraction, therefore, maintains a certain amount of the progress made during each contraction. It will also be noticed that retraction must cause some diminution in the superficial area of the uterine wall ; this is of importance in regard to the mechanism of separation of the after-birth. In cases of

obstructed labour retraction becomes greatly exaggerated, so that the retraction ring forms a ridge which can be recognised by palpation through the abdominal walls (see p. 412). In cases of unobstructed labour its presence cannot be recognised by clinical observation.

Dilatation of the lower segment and cervix is brought about by the uterine contractions acting either through the bag of waters or directly through the presenting part. The conical shape and elastic consistence of the bag will enable it to dilate the canal equally, acting as a 'fluid wedge.' The presenting part forms a much less efficient dilator, partly because it is inelastic, partly because it does not adapt itself so readily in shape to the dilating canal. Retraction plays an important part in the process of dilatation of the lower segment and cervix. The retracting and progressively shortening uterus pulls up the cervix, like a sleeve, over the advancing lower pole of the ovum (bag of waters or presenting part). Dilatation, therefore, is accomplished by two distinct processes which act in conjunction : (1) the advance of the lower pole of the ovum, (2) the drawing up of the cervix over it. The level of the cervix thus gradually rises during labour, though, because of the stretching of the lower uterine segment, the extent to which the cervix rises is by no means proportional to the shortening of the active upper uterine segment. The ascent of the cervix, which can be appreciated clinically by vaginal examination during labour, explains the gradual ascent of the bladder into the abdomen. The position of the bladder and uterovesical pouch during the early part of the second stage of labour is shown in Fig. 114.

Anything interfering with the normal mechanism, such as inefficient contractions, premature rupture of the membranes, or structural alterations in the cervix, will prevent or delay the occurrence of dilatation.

The Labour Centre.—It is possible that the process of parturition is under the control of a special centre in the lumbar enlargement of the spinal cord, for it is well known that in certain animals powerful uterine contractions can be induced by experimental stimulation of the lumbar enlargement. Also, women suffering from paraplegia due to injury or disease affecting the cord above the level of the lumbar enlargement may pass through an easy and rapid labour, which is, of course, painless. These facts, however, do not suffice to prove the existence of a labour centre ; for large sympathetic ganglia are found at the sides of the uterus, between the layers of the broad ligament, which may, by automatic action, themselves induce contractions. Certainly in some animals rhythmic contractions of the uterine muscle may be induced by stimulating these ganglia, or the uterus may be made to contract after its removal

from the body in the same manner. In the human subject, however, the balance of probability is in favour of the existence of a centre in the cord.

The manner in which the nerve centres, whether peripheral or spinal, are so excited as to initiate the process of labour is unknown. The onset of labour is no doubt due in some way to stimulation of these centres, and although many hypotheses have been advanced, the fact remains that there is little or no evidence in favour of any of them, and accordingly they need not be discussed. The progressive increase in the activity of these centres when once labour has begun may be simply explained by peripheral stimuli coming from the uterine nerves, which are stretched by dilatation or compressed by muscular contraction.

General Effects of Labour.—During a uterine contraction it is noticed that the fœtal heart beats more slowly and more feebly, but quickly recovers its normal action as the pain passes off. The uterine souffle becomes louder at the beginning of a contraction, then rapidly diminishes, and becomes quite inaudible at the acme of the contraction. The mother's pulse is quickened during the contractions. The amount of blood lost during normal labour averages about 10 ounces, more than half of which accompanies the placenta. In women of average physique, the general effects of normal labour are usually those of physical exhaustion, corresponding with the length and severity of the labour pains. The temperature may be elevated one or two degrees and the pulse a little accelerated—ten to fifteen beats above the normal. In women of less than average physique, normal labour sometimes leads to alarming *surgical shock*, accompanied by pallor, coldness of the body surface especially of the limbs, rapid and feeble pulse, and a sub-normal temperature ; sometimes there is loss of consciousness. There may be no unusual hæmorrhage in such cases. Treatment by the application of heat to the body, the rectal injection of warm saline solution, and the subcutaneous injection of camphor is usually successful. The authors have, however, seen two cases in which the symptoms were so alarming that intravenous saline transfusion was resorted to. A certain number of fatal cases have been recorded.

Acute dilatation of the heart sometimes occurs after labour in persons not previously known to suffer from heart lesions. In all probability some cardiac defect has passed unobserved in such cases. A trace of albumen is frequently found in the urine of perfectly healthy women during normal labour ; this is especially common in primiparæ.

Anatomy and Physiology of the Third Stage of Labour

It has now been demonstrated by the study of frozen sections that separation of the placenta and the greater part of the mem-

branes does not occur until the third stage (see Fig. 115). At the beginning of this stage the uterus measures about 8 inches (20 cm.) vertically and 4 inches (10 cm.) antero-posteriorly ; its wall is greatly thickened at all parts except the placental site. The uterine cavity is so reduced that the placenta almost fills it. The lower uterine segment is loose and thrown into folds. The membranes are still attached to the uterine wall

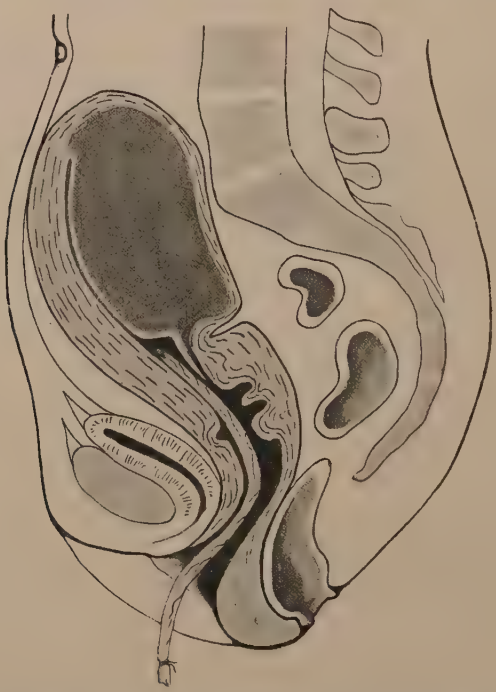


Fig. 138.—Sagittal Section showing Placenta *in Utero* after Birth of Child. Note thinness of wall of uterus at placental site, and folding of flaccid lower uterine segment. No separation of placenta has taken place. (Modified after Pestalozza, Anatomia dell' Utero Umano : Vallardi, Milano.) (Galabin and Blacker.)

except in the lower segment, from which they become detached during the stage of dilatation, while the placenta is folded and much reduced in size. The plane of cleavage runs through the cavernous layer of the decidua basalis (Fig. 19), the deepest part of which remains attached to the uterine wall.

It is, however, quite clear that in the great majority of cases the placenta is delivered in one of the following two ways : (1) In some instances a portion of the placenta near its centre becomes separated, and hæmorrhage from the torn uterine

sinuses occurs at that spot. As more blood is effused, an increase in the area of separation occurs by the formation of a retro-placental blood-clot. The centre of the placenta is thus forced down towards the cervix, where its fœtal surface, with the umbilical cord attached, presents ; it then passes through the aperture in the membranes formed by the passage of the fœtus, and enters the vagina, pulling the membranes off behind it and turning them inside out. This mode of separation,

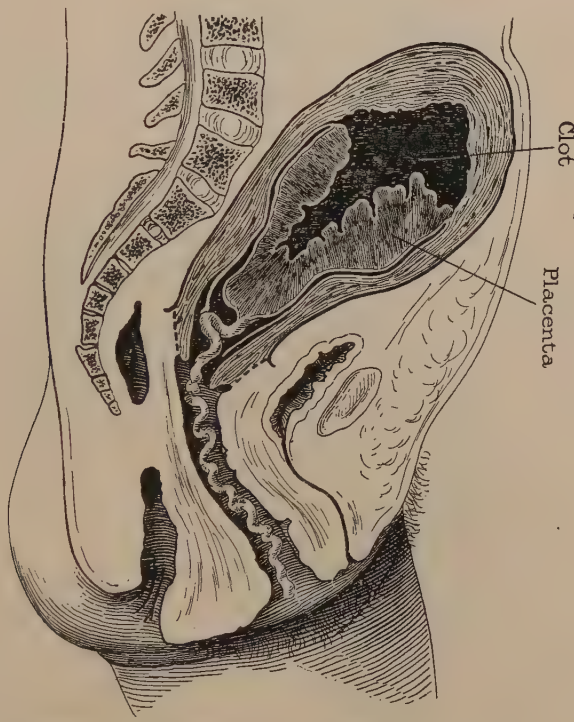


Fig. 139.—Separation of the Placenta by Formation of Retro-placental Clot (diagrammatic). (Varnier.)

which can frequently be observed, was first described by Schultze. It is diagrammatically represented in Fig. 139, and is shown *ad naturam* in Fig. 140, in a uterus removed from the body after death. (2) The second mode of separation of the placenta is illustrated in Figs. 141 and 142, and was first clearly described by Matthews Duncan. Detachment begins at the lower pole, which is not subjected to the same amount of compression as the remainder of the placenta, on account of the patulous condition of the cervical canal, and the whole organ is gradually forced into the cervix, the upper pole being the last

to leave the uterine cavity. The edge or the uterine surface of the placenta presents in this case.

The mechanism of the latter mode of separation has been explained by Barbour as follows: When retraction occurs

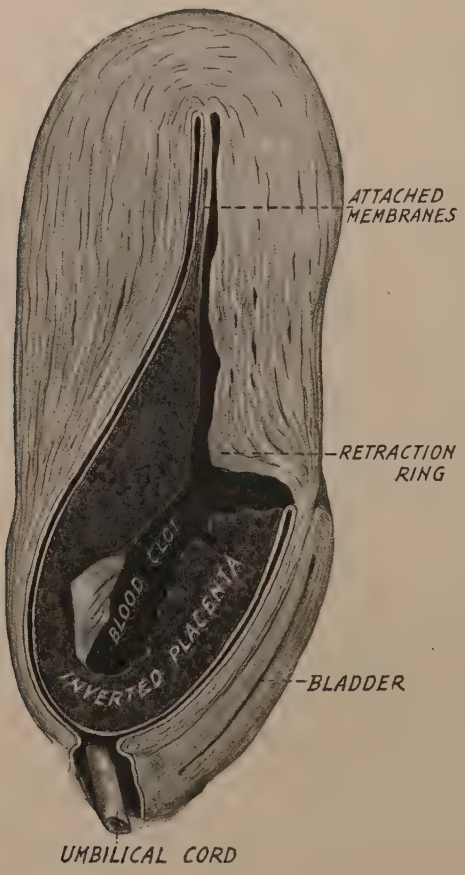


FIG. 140.—Uterus in the Third Stage. The placenta is inverted and detached, lying in the lower segment. It is held up by adhesion of the membranes to the fundus. A small retro-placental clot has been formed. (Barbour's Anatomy of Labour.)

after the expulsion of the child, the area of the uterine surface is much diminished; the placenta, being an inelastic organ, cannot follow this diminution to any great extent, and therefore becomes detached, the uterine wall tearing itself away from the placenta. This process begins at the lower pole, because there the edge is entirely unsupported. Separation, thus

begun, is advanced by each recurring contraction. In the case of the first-mentioned mode of separation, on the other hand, relaxation of the uterus at the placental site, leading to effusion of blood, is probably the initial factor in its production ; this mode of separation will therefore be met with when retraction in the third stage is inadequate. It has been suggested that in cases of fundal insertion of the placenta the same result may occur without hæmorrhage ; the central portion of the

FIG. 141.—Separation of the Placenta from below upwards (diagrammatic). (Bumm.)

placenta, being then unsupported, becomes first detached by retraction and then driven downwards by contractions, thus causing the fœtal surface to present in the cervix.

The separated placenta is expelled through the cervix, vagina, and vulva mainly by the action of the accessory muscles; uterine contractions are at this stage too feeble to play any important part in the process of expulsion.

From statistics of the Rotunda Hospital, Dublin, it appears that the placenta separates by the Schultze method much more

commonly than by the other, the proportions being about 83 per cent. to 17 per cent. It also appears that the former

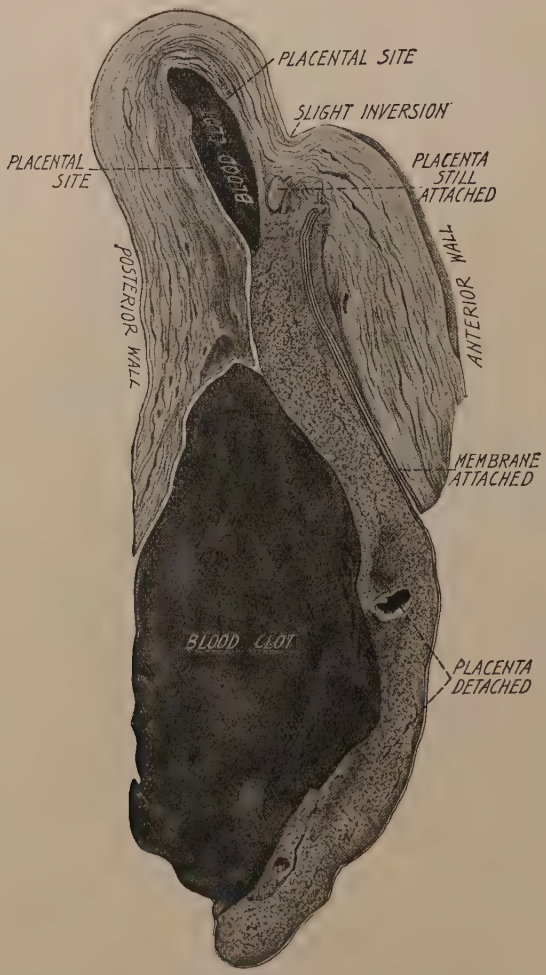


FIG. 142.—Uterus in the Third Stage. The placenta presents by its edge, and is adherent at one point to the uterine wall, producing a partial inversion. An enormous retro-placental clot has been formed, which was the cause of death. (Barbour's Anatomy of Labour.)

mechanism is the more favourable, for the membranes were found to be incomplete three times more often with the Matthews Duncan than with the Schultze mechanism.

The Mechanism of Normal Labour

In this section will be described the effects produced by the expulsive forces upon the ovum, and the manner in which the process of expulsion is accomplished.

First and Second Stages.—It will be understood that during the greater part of the process of labour the uterine contractions do not act directly upon the body of the fœtus, for the latter is completely protected by the amniotic fluid. Pressure

FIG. 143.—*General Intra-uterine pressure.*—The arrows indicate the directions of the force exerted by the general intra-uterine pressure, (*a*) on the uterine contents; (*b*) on the walls of the uterus (a "bursting-stress").

The two long arrows indicate the direction of the pull on the cervix by the contracting longitudinal muscle fibres of the uterus.

FIG. 144. — Direct Intra-uterine, or Fœtal-Axis-Pressure. (Dakin.)

is transmitted to the fœtus only through this fluid covering, and since pressure is transmitted by a fluid medium equally in all directions, the effect must be mainly of the nature of general compression by increase of intra-uterine tension (*general or indirect intra-uterine pressure*) (Fig. 143). In this way an expulsive action will, however, be exerted upon the complete ovum (membranes unruptured), causing it to protrude through the dilating cervix, and in some cases an unruptured ovum may be thus completely expelled from the uterus; but here

the expulsive forces never act directly upon the body of the fœtus at all. While the membranes remain intact, or when sufficient liquor amnii is retained, it follows that no effects injurious to the fœtus can be produced. The direction of the advance at this stage must be that of least resistance—viz., through the expanding cervix. This direction will be represented by a line drawn at right-angles to the plane of the internal os—the *axis of the internal os*. When the uterus is made erect by contraction, and there is only slight lateral obliquity, the axis of the uterus and the axis of the internal os

Fig. 145.—Vertex Presentation. First Position (L.O.A.). (Farabœuf and Varnier.)

are almost identical, and correspond with the axis of the pelvic brim.

When the membranes have ruptured and the greater part of the liquor amnii has escaped—*i.e.*, towards the end of the second stage of labour—the contracting uterine wall comes down upon the body of the fœtus, exerting pressure directly upon it (*direct intra-uterine pressure*) (Fig. 144). The driving force now acts upon the breech, and the line of advance will be the line of the fœtal axis ; this corresponds under normal conditions to the axis of the pelvic inlet. The term *fœtal-axis-pressure* is often applied to the uterine force at this stage. Force thus exerted upon the trunk of the fœtus, when the head is in the pelvic cavity, will cause the head to advance in the

direction of that part of the pelvic axis to which it corresponds at the time. It will be clear that prolonged pressure in these circumstances may produce injurious effects through direct compression of the body of the fœtus, the placenta, or the cord.

In normal labour the progress of the fœtus through the birth-canal is watched by observing the advance of the fœtal head ; the relation of the head to the pelvic brim at the commencement of labour is therefore of great importance. It has already

Fig. 146.—Vertex Presentation. Second Position (R.O.A.). (Farabœuf and Varnier.)

been stated that the vertex presents in 96 per cent. of all labours. This predominant frequency is due to two causes : (1) under normal conditions the fœtal ovoid adapts itself best to the shape of the uterus when the head lies below, the breech above ; (2) the centre of gravity of the fœtus lies nearer the head than the breech : therefore the fœtus will, if undisturbed, float in the liquor amnii with the head below.

With the vertex presenting, the fœtus may occupy four different *positions :* the back may be anterior and directed either to the left or right of the mother ; or the back may be posterior and directed either to the right or left of the mother. The part of the vertex which corresponds with and indicates the position of the back is, of course, the occiput ; this is termed

the *denominator* of the positions which are named from it thus (Figs. 145 to 148) :

1st position	. .	Left occipito-anterior	. . L.O.A.
2nd ,,	. .	Right occipito-anterior	. R.O.A.
3rd ,,	. .	Right occipito-posterior	. R.O.P.
4th ,,	. .	Left occipito-posterior	. . L.O.P.

The term *position* thus indicates the relation of the back of the fœtus to the mother, and it will be found that in all kinds of presentation the four positions correspond. In the first and third position the diameter of engagement of the head roughly corresponds with the right oblique diameter of the pelvic brim ;

Fig. 147.—Vertex Presentation. Third Position (R.O.P.). (Farabœuf and Varnier.)

in the second and fourth positions it corresponds with the left oblique.

The relative frequency of the various positions of the vertex, as calculated from a series of 10,000 consecutive cases in Queen Charlotte's Lying-in Hospital, is as follows :

1st position.	. 53·1%	Right oblique diameter	. 67·1%
2nd ,,	. 21·4%		
3rd ,,	. 14·0%		
4th ,,	. 11·5%	Left ,, ,,	. 32·9%

Although differences of opinion as to the exact proportions may be held, it is now generally agreed that the first is the most frequent and the fourth the rarest.

From this it will be seen that the vertex engages in the right oblique diameter much oftener than in the left ; this is mainly due to the fact that the left oblique is encroached upon by the pelvic colon and rectum, and therefore does not accommodate the head so well as its fellow. Again, the first position is three to four times more frequent than the third ; this is to be accounted for by the fact that the fœtus lies more easily in the uterus when the back is anterior than when it is posterior. In the latter the convexity of the fœtal spine is opposed to the convexity of the maternal lumbar vertebræ, while in the former the ventral aspect of the fœtus adapts itself easily to the

Fig. 148.—Vertex Presentation. Fourth Position (L.O.P.). (Farabœuf and Varnier.)

curve of the spinal column. In the fourth position, the rarest, the conditions are the least favourable—viz., engagement in the left oblique diameter, and posterior position of the back. As we shall see, the posterior position of the back is also apt to cause some disturbance of the normal fœtal attitude of flexion.

The study of frozen sections has proved that when the vertex engages in the pelvic brim, owing to the lateral inclination of the head and to other causes, one parietal bone frequently lies at a lower level than the other ; as a result the sagittal suture does not correspond precisely to the oblique diameter, but lies either in front of or behind it. This is known as *asynclitism or parietal obliquity* (Fig. 149). Usually the head inclines to the posterior

shoulder, the anterior parietal bone is below the posterior, and the sagittal suture nearer the promontory than the symphysis (*anterior asynclitism, anterior parietal obliquity, Naegele's obliquity*); sometimes, however, the sagittal suture lies nearer the symphysis than the promontory (*posterior asynclitism, posterior parietal obliquity*). The former is found chiefly in multiparæ, the latter in primiparæ, the reason being that in primiparæ the relatively tense abdominal walls tend to keep the uterus back and so prevent the body of the fœtus from coming forward into the line of the axis of the brim; accordingly, when the head

FIG. 149 (*a*).—Anterior Asynclitism: Naegele's Obliquity. (Bumm.)
The trunk lies away from the maternal spine.

enters the brim the posterior parietal bone is lower than the anterior (Fig. 149 (*b*)). Sectional anatomy has shown that in some cases (about 25 per cent.) this lateral inclination is absent, and the sagittal suture corresponds to the oblique diameter of the pelvis. It is probable that under normal conditions asynclitism is corrected very early in labour; pronounced or persistent asynclitism is abnormal and only occurs with certain varieties of contracted pelvis.

The relation of the head to the pelvis at the onset of labour in the four positions of the vertex as it appears when viewed through the outlet is shown in Figs. 150 to 153. It will be seen that the sagittal suture roughly corresponds to one of the

oblique diameters, but may lie a little in front of or behind it as asynclitism is more or less pronounced. At one end of the suture lies the anterior fontanelle, at the other end the posterior fontanelle. If the head is well flexed, the posterior fontanelle is lower than the anterior ; if the head is imperfectly flexed, this will not be the case. These points will again arise in connection with the diagnosis of position.

In passing through the pelvis, the fœtus, in addition to following the curved line of the pelvic axis, describes a certain definite series of movements which alter its relations to the

FIG. 149 (*b*).—Posterior Asynclitism. (Bumm.)
The trunk lies close to the maternal spine.

pelvic canal. The valuable information obtained by the study of frozen sections of women who have died in labour has made it necessary to modify certain of the older views regarding the nature and causation of these movements. It is customary to describe them as movements of the head, but in reality the head is only the index ; external rotation is essentially a movement of the trunk, and it is probable, as we shall see, that the same is also true of flexion and extension.

It will, of course, be understood that throughout the first and second stages of labour there is a more or less continuous movement of *descent*. Accompanying this, four other movements are described—viz. : (I.) *Flexion ;* (II.) *Internal Rotation ;* (III.) *Extension ;* (IV.) *Restitution and External Rotation.*

I. *Flexion.*—Sectional anatomy has shown that under normal conditions the head, as a rule, is flexed before labour begins. The degree of flexion is, however, subject to a slight

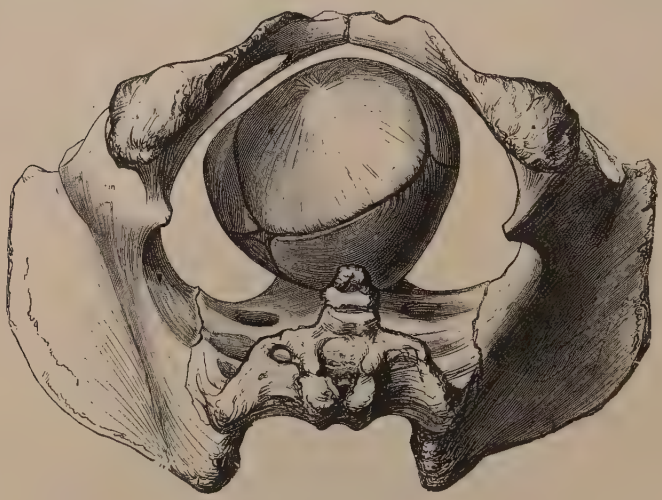


Fig. 150.—First Position of he Vertex (L.O.A.), Anterior Asynclitism.

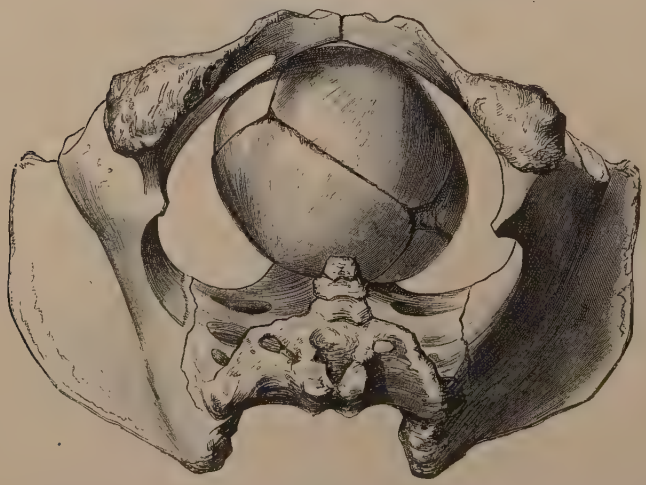


Fig. 151.—Second Position of the Vertex (R.O.A.).

variation, even under normal conditions; when fully flexed the chin is in contact with the chest, but this may be modified by an unusually high position of the arms (Fig. 131), or by other causes. Flexion, therefore, is an *attitude*, not a *movement*, and

the old view that it was normally produced during labour must be abandoned. Disturbances of the normal fœtal attitude of flexion at the onset of labour are, however, not uncommon,

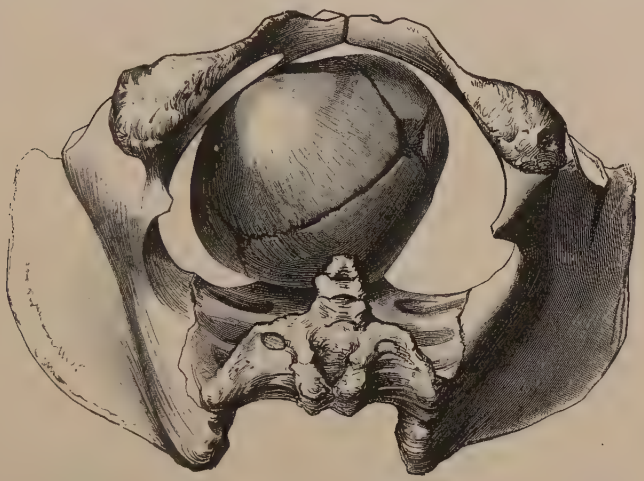


Fig. 152.—Third Position of the Vertex (R.O.P.). Incomplete Flexion.

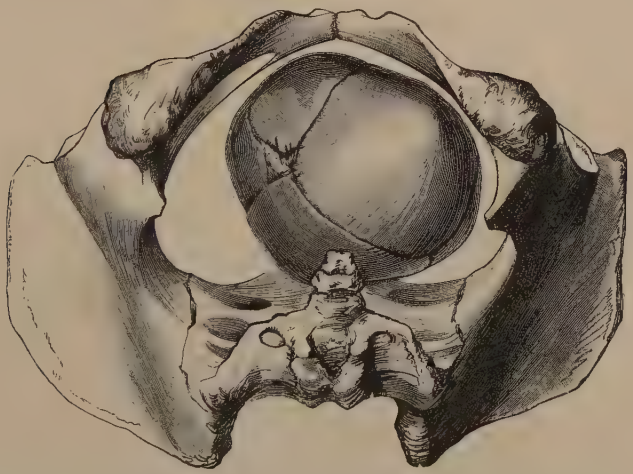


Fig. 153.—Fourth Position of the Vertex (L.O.P.), Anterior Asynclitism. Incomplete Flexion.

causing the head to enter the brim in an attitude of deficient flexion or of extension. During its passage through the pelvis it may then become flexed, and the mechanism of the process may therefore be briefly referred to, but it must be understood

that such explanations are superfluous when the attitude of the fœtus before labour is normal. The conventional explanations of the movement of flexion are :

(a) *The Wedge Theory.*—When the fœtal head is looked at from the side it will be observed that its outline forms a wedge with unequal sides ; the apex of the wedge is near the posterior end of the sagittal suture, and the posterior side is steeper than the anterior (Fig. 154). In a vertex presentation, when the head is incompletely flexed, the steep posterior side of the wedge will meet with less resistance from contact with the passages than the anterior—*i.e.*, the occiput will advance more quickly than the sinciput, and the head will thus tend to move upon the occipito-atlantoid articulation into the attitude of flexion. This effect will be increased by the elastic pressure exercised by the resisting girdle of contact, for this pressure is applied to the front and back of the head at slightly different levels, thus forming a *couple of forces*, the tendency of which must be to rotate the head still further upon its transverse axis so as to bring the occiput lower than the sinciput (Figs. 155 and 156). These effects will be produced at all periods of the first and second stages whether the membranes are ruptured or not.

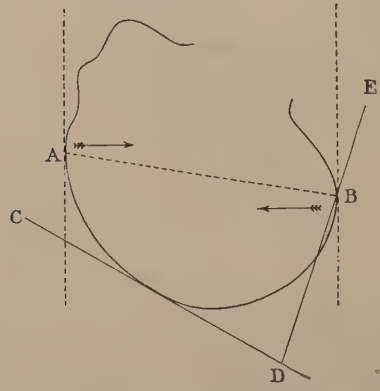


FIG. 154.—Effect of the Wedge Shape of the Head in producing Flexion. (Modified from Galabin.)

A, B. Diameter of engagement. C, D. Slope of anterior side of lateral wedge. E, D. Slope of posterior side of lateral wedge. The arrows indicate the effect of the elastic pressure of the girdle of contact.

(b) *The Lever Theory.*—From the manner in which the head is articulated to the vertebral column, the head represents a two-armed lever with the fulcrum at the occipito-atlantoid joint and with the anterior arm longer than the posterior ; consequently, when resistance is encountered, the long arm will ascend and the short arm descend, bringing the occiput lower than the forehead and increasing flexion.

It must be recollected that when flexion is deficient the diameter of engagement is longer than when it is complete (Figs. 152 and 153), and the difficulties attending the passage of the head are consequently greater. When the head is flexed to the greatest possible extent, the sub-occipito-bregmatic diameter engages. The shape of the head in the plane of this diameter is shown in Fig. 157, *a* ; its dimensions are well within

FIG. 155.—Vertex Presentation. First Position. The head is incompletely flexed, the diameter of engagement being approximately the occipito-frontal; pelvis divided in right oblique diameter. (Farabœuf and Varnier.)

FIG. 156.—Vertex Presentation. First Position. The head is completely flexed, the diameter of engagement being the sub-occipito-bregmatic. (Farabœuf and Varnier.)

those of the pelvic brim or cavity. When the head is less fully flexed, the sub-occipito-frontal diameter becomes engaged ; the shape and size of the plane of this diameter are shown in Fig. 157, *b*. This plane is approximately quadrilateral, and is therefore not so well adapted to pass easily through the pelvis, while its dimensions are, of course, greater than those of the sub-occipito-bregmatic plane. When the head is midway

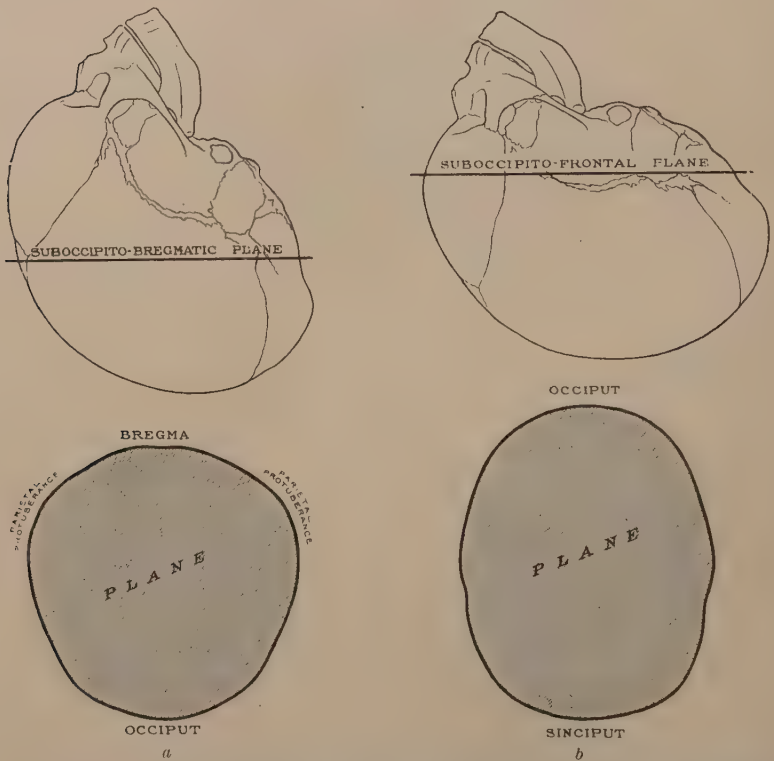


FIG. 157.—*a*, The Position and Shape of the Sub-Occipito-Bregmatic Plane of the Fœtal Head. *b*, The Position and Shape of the Sub-Occipito-Frontal Plane of the Fœtal Head. (Edgar.)

between complete flexion and complete extension, the occipito-frontal diameter engages, and the plane of this diameter has the same shape, but is of even larger size than the sub-occipito-frontal (Fig. 158). It will therefore be apparent that complete flexion of the head is of great mechanical advantage in a vertex presentation, since in this position the plane of engagement is not only the smallest possible, but also of a shape which will readily pass through the pelvic canal. It is, however, probable

that at the beginning of labour the head usually engages in the sub-occipito-frontal plane, or in a plane intermediate between this and the sub-occipito-bregmatic, and if the dimensions of the head and the pelvis are normal, it may pass through without any marked increase of flexion being produced.

II. *Internal Rotation.*—The head enters the pelvic brim, as we have seen, approximately in the oblique diameter ; internal rotation is a movement which carries the head into the antero-posterior diameter of the pelvic outlet. The advantage gained by this movement is that the diameter of engagement is brought into the longest diameter of the pelvic outlet. In the first and second positions internal rotation almost always brings the occiput forwards under the pubic arch ; in the third and fourth positions the same thing usually occurs ; but sometimes, from causes which will be mentioned later, the occiput rotates backwards into the sacral hollow while the sinciput comes to the front. In the first and fourth positions the direction of forward rotation is from left to right, in the second and third from right to left.

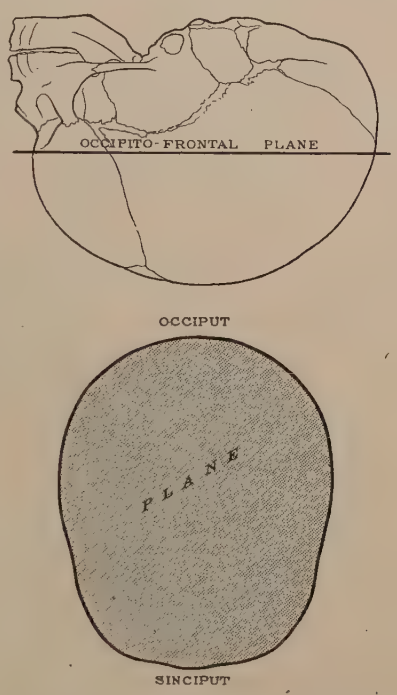


Fig. 158.—The Position and Shape of the Occipito-Frontal Plane (Edgar.)

Forward Rotation of the Occiput.—The essential cause of this movement is the influence of the *sloping pelvic floor*. As we have seen, the soft parts forming the pelvic floor slope from behind forwards and downwards, and from the sides forwards, downwards, and inwards—towards the middle line. Therefore a body coming in contact with any part of the pelvic floor will be directed by it forwards and downwards under the pubic arch. When the head is flexed the posterior part of the vertex reaches the pelvic floor in advance of the anterior (Fig. 156), and is accordingly directed forwards by its slope ; in other words, the occiput rotates under the pubic arch. This will occur whether the occiput lies in an anterior or a posterior position. Since the pelvic floor is deficient anteriorly in relation

to the wide pubic arch, the part of the head which moves forward is moving in the direction of least resistance, and there is nothing to oppose it. The movement of forward rotation is much longer in posterior than in anterior positions of the vertex, the difference being represented by about a quarter of a circle.

Braune's section of a woman who died during the second stage (Fig. 114) shows the movement of internal rotation in

FIG. 159.—Section showing Partial Extension of Spine when the occiput is behind. (Modified from Varnier, Pratique des Accouchements, Fig. 172.)

progress, the occiput coming forwards, while dilatation of the vulva has begun.

Backward Rotation of the Occiput.—If, in an occipito-posterior position, the head is extended so as to bring the occipito-frontal diameter into the pelvic brim, the anterior end of the vertex will form its lowest part. When this part reaches the pelvic floor it will be directed downwards and forwards under the pubic arch, and the occiput will consequently pass backwards into the sacral hollow. The primary cause of backward

rotation is, therefore, extension of the head. While it is extremely rare in anterior positions, extension is not uncommon in posterior positions, and is amply accounted for by two considerations : (1) In posterior positions the general attitude of flexion is disturbed by some degree of extension of the spine which results from the opposition of the two convexities of the fœtal back and the maternal lumbar vertebræ ; if the fœtal spine becomes extended the fœtal head will become extended also. This implies that some degree of extension is present at the beginning of labour. (2) Extension may be produced or increased during labour by the unfavourable position in which the head is placed (Fig. 160). The widest part of the fœtal head lies behind its centre and corresponds to the bi-parietal diameter. In a posterior position this diameter lies behind the oblique diameter of the brim, between the sacral promontory and the ilio-pectineal eminence—a position where space is limited, and it therefore meets with opposition to its descent. The narrow sincipital end, on the other hand, lies in the widest part of the pelvis where it can descend easily ; consequently the head becomes extended.

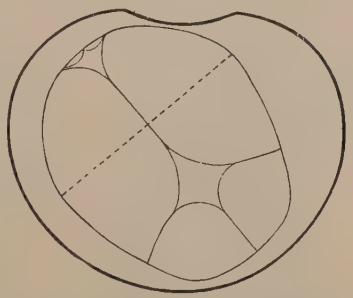


FIG. 160.—Occipito-Posterior Position of the Vertex. (Herman.)

The dotted line indicates the bi-parietal diameter.

Another possible factor in the production of backward rotation may also be mentioned. If the head is so extended as to make the occipito-frontal the diameter of engagement, the length of the transverse diameter of the pelvic cavity will form a mechanical obstacle to forward rotation of the occiput. The diameter measures $4\frac{1}{2}$ inches—*i.e.*, about the same as the occipito-frontal ; yet, if forward rotation occurs, the head must pass through this diameter before the occiput can reach the pubic arch. It will clearly be easier for the occiput to pass backwards, thus bringing the diameter of engagement immediately into the long diameter of the outlet. If the vertex is flexed, no difficulty will be occasioned in forward rotation by the length of the transverse diameter.

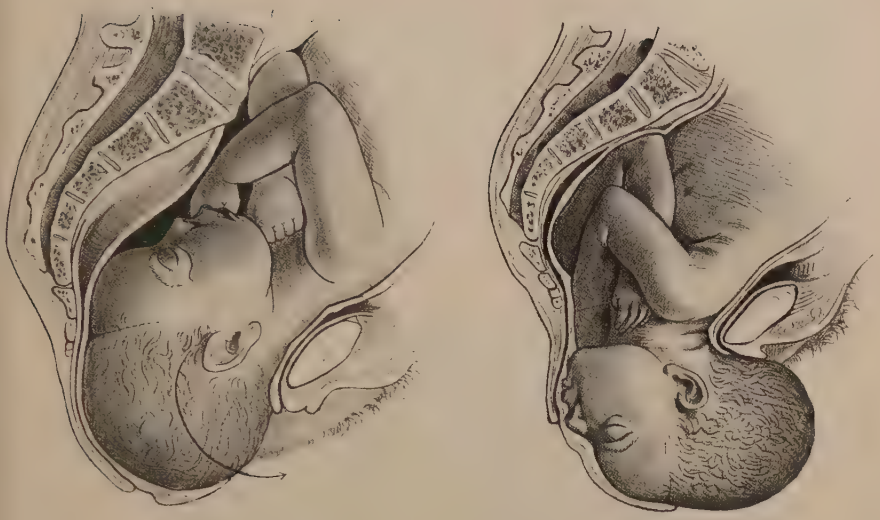
It will be understood from what has been said that, while backward rotation may exceptionally occur in anterior positions, this occurrence is extremely rare and can only be rendered possible by marked extension of the head. In posterior positions it occurs in about one case in ten. When backward rotation takes place the condition is called a *persistent occipito-posterior* or *face-to-pubes case.*

III. *Extension.*—After internal rotation has been completed the head emerges at the vulva, the occiput coming first, then successively the vertex, forehead, and face. When the chin slides over the edge of the perineum, it of course becomes separated from the chest-wall—*i.e.*, the head becomes extended. It is probable, however, that extension begins earlier than this, and is, in fact, part of a general change in the attitude of the fœtus which takes place towards the end of the second stage. The attitude of the fœtus shown in Fig. 161 is the same as that seen *in utero* in Fig. 162. When carefully examined it will be noticed that flexion of the trunk is not nearly so marked as before the onset of labour, this change being clearly indicated by the interval which here exists between the folded arms and the knees. The chin is also no longer in contact with the chest. In other words, extension has already begun; it is probably a normal occurrence at this stage of labour. Complete extension of the head only occurs, however, in the actual process of expulsion through the vulva. The steps of this process are shown in Figs. 162 and 163. It will be observed that the interval between the chin and the chest-wall progressively increases as the head is expelled, while the back of the neck becomes bent over the pubes.

Fig. 161.—Fœtus from a Frozen Section of a Woman who died in Labour towards the End of the Second Stage, showing Extension of the Trunk. (Barbour.)

IV. *Restitution and External Rotation.* — These are movements of the neck and trunk, the head being merely the index. (1) *Restitution.*—While the head is emerging in the antero-posterior diameter of the outlet, the shoulders engage in the oblique diameter of the brim (Fig. 164). In this attitude there is slight torsion of the neck, and when the head is free a slight movement occurs, bringing it back into its normal relation to the bis-acromial diameter. In first and fourth vertex positions this movement is represented by a slight turn of the occiput to the mother's left, in second and third to the mother's right.

(2) *External Rotation* represents the movement of the shoulders from the oblique diameter of the brim to the antero-posterior diameter of the outlet, in which they are born. The



(*a*) (*b*)

FIG. 162.—The Stages of the Movement of Extension in the Expulsion of the Head.

(*a*) (*b*)

FIG. 163.—The Stages of the Movement of Extension in the Expulsion of the Head.

anterior shoulder rotates forwards under the pubic arch, and in first vertex positions this movement carries the occiput still further round to the mother's left, so that the face is now directed to the right thigh (Fig. 165). External rotation is thus a continuation of the movement of restitution.

It is unnecessary to describe separately the movements of the head in all four positions of the vertex. Posterior positions differ from anterior chiefly in their liability to be associated with deficient flexion and in the variation of the movement of

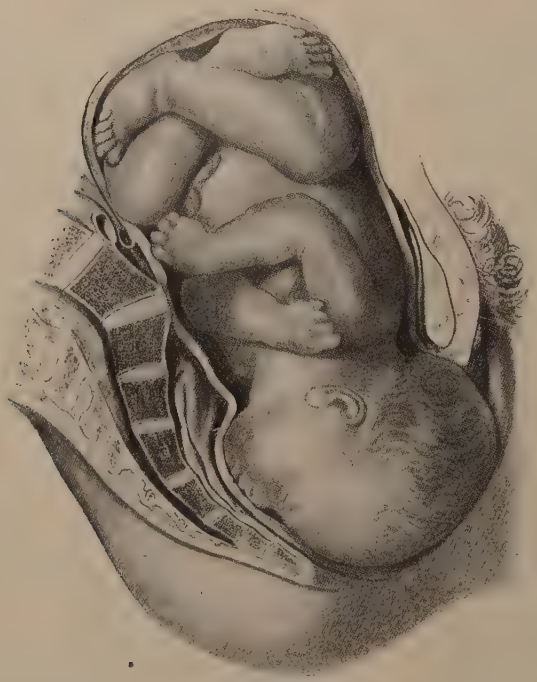


Fig. 164.—Showing the Position of the Shoulders before the Movement of External Rotation.

internal rotation which is thus brought about. As regards internal rotation, the conditions which induce forward or backward rotation have been indicated. In the movements of restitution and external rotation, the occiput always moves to the side where it lay at the commencement of labour.

Effect of Labour upon the Fœtal Head.—During labour the head is subjected to the action of compressive forces which are the resultant between the powers of labour and the resistance of the maternal passages; it is most important to realise how these forces act and the effects they produce. The head is

structurally a non-rigid shell composed of loosely joined plates of pliable bone attached to a rigid base and strengthened internally by the attachment of the dura mater and its septa; the contents of this shell are partly solid and partly fluid and do not lie in an absolutely closed space, for a certain amount of blood and cerebrospinal fluid can be squeezed out of it. The head therefore possesses a considerable degree of plasticity, and during labour undergoes an alteration in shape known as *moulding*. In normal vertex presentations the pressure of the

FIG. 165.—Showing the Position of the Head and Shoulders after the Movement of External Rotation.

girdle of contact is applied in the plane of the sub-occipito-bregmatic or sub-occipito-frontal diameters; this plane, therefore, becomes somewhat compressed, while compensatory elongation occurs in the plane at right angles to it—*i.e.*, the vertico-mental plane. The head consequently becomes lengthened in its vertico-mental diameter and shortened in its sub-occipito-frontal diameter (Fig. 167). The effect of moulding in occipito-posterior positions is described on p. 314. As a result of moulding the bones of the vault also overlap one another in a particular way. The tabular portion of the occipital bone

becomes depressed so as to deepen the posterior fontanelle, while the edge of the bone slides under the posterior edges of the parietal bones (Fig. 166). The same change occurs, but to a less extent, at the sagittal suture; one or other parietal bone becomes slightly depressed beneath its fellow along the sagittal suture. It should be realised that moulding of the head is essentially an alteration in shape, and that the head is hardly, if indeed at all, altered in size, for the amount of blood and cerebro-spinal fluid that can be squeezed out is too small to make any appreciable difference, and the brain is incompressible.

The degree of moulding met with is proportional to the pressure to which the head is subjected during labour. Physiological moulding is harmless and is very advantageous, as it

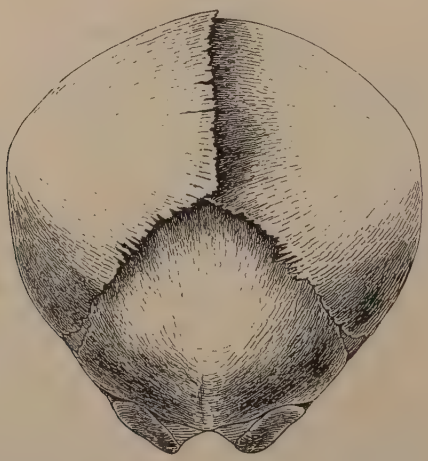


Fig. 166.—Head Moulding, showing Overlapping of Bones at the Lambdoidal and Sagittal Sutures. (Ribemont-Dessaignes and Lepage.)

enables the head to pass more easily through the birth-canal. But extreme moulding (Fig. 168), such as occurs in the case of an over-sized head or an under-sized pelvis, is, on the other hand, distinctly pathological, and may result in severe intracranial disturbances, the chief of which are tearing of the tentorium cerebelli and subdural cerebral hæmorrhage. It will also be realised that the extremely plastic head of a premature fœtus is much less able to resist pressure than the firmer head of a mature fœtus. The subject of extreme moulding is further dealt with in the section on fœtal injuries.

The pressure of the girdle of contact upon the head also indirectly produces changes in the scalp. As the head is driven down, and the passages dilate, the part of the scalp lying in the centre of the birth-canal is free from pressure, while the part

immediately above and around it is firmly compressed by contact with the maternal tissues. From interference with venous return effusion of serous fluid into the subcutaneous cellular tissue takes place upon the exposed area of the scalp, forming a swelling known as the *caput succedaneum*. It is clear that this change will occur at the end of the first and during the second stages of labour ; it is seldom met with until after the membranes have ruptured. In the *first position* of the vertex the right parietal bone lies in front of and below the left, and, owing to the flexed position of the head, the posterior end of the bone lies at a lower level than the anterior. The exposed area therefore corresponds to the posterior end of the right

FIG. 167.—Slight Moulding of the Fœtal Head in Vertex Presentation.

FIG. 168.—Extreme Moulding of the Fœtal Head in Vertex Presentation.

The linear outline represents the shape of the head before labour.

parietal bone, close to the sagittal suture (Figs. 150 and 151), and in this position the caput forms. The size of the caput is proportional to the degree of compression—which again depends upon the relation in size of the head and the pelvis—and to the length of time which elapses between rupture of the membranes and expulsion of the head. The presence of a large caput upon the head is therefore an important sign of difficulty in labour. The side of the head upon which the caput is formed depends upon *position ;* its exact place upon the parietal bone depends upon the degree of *flexion* of the head. In first and fourth positions it is on the right parietal, in second and third positions upon the left ; when the head is fully flexed it is placed far back, close to or overlapping the posterior fontanelle ; when the head is incompletely flexed it will be found more anterior, and may

even be near the anterior fontanelle. The usual location of the caput is therefore as follows :

1st position . .	Posterior end of right parietal.
2nd ,, . .	Posterior end of left parietal.
3rd ,, . .	Middle or front of left parietal.
4th ,, . .	Middle or front of right parietal.

But if in third and fourth positions the head is well flexed, the caput will be formed nearer the posterior part of the bone.

Fig. 169.—Caput Succedaneum in First Vertex Position. (Ribemont-Dessaignes and Lepage.)

If after internal rotation has occurred the head is long delayed on the pelvic floor, a caput will form upon the part of the scalp which presents at the vulva—*i.e.*, the region of the occipital bone near the posterior fontanelle. This is sometimes called the *secondary* caput succedaneum ; its place is the same in all positions of the vertex when forward rotation of the occiput has occurred ; it will be found upon the sinciput in face-to-pubes cases.

It will be seen that the position of the *caput* and the nature of the moulding are useful indications of the position occupied by the head in the pelvic cavity. They must be noted immediately after birth, as moulding often disappears in a few hours, and the caput is always absorbed in from twenty-four to forty-eight hours.

The Management of Labour

In this section will be considered (I.) *Antiseptics in labour ;* (II.) *Diagnosis*, including the recognition of the conditions present and the means of watching the progress of labour ; (III.) *Narcosis and anæsthesia in labour ;* (IV.) *Uterine stimulants in labour ;* (V.) *The Delivery of the child and of the afterbirth ;* (VI.) *The Toilet of the mother and the child.*

I. **The Aseptic Conduct of Labour.**—No aspect of the management of labour is so important as the imperative necessity for the employment of sound and reliable methods of surgical cleanliness. This subject will therefore be considered first.

Every case of labour must be conducted with the most scrupulous attention to surgical cleanliness on the part of all who are in attendance upon the patient. Puerperal infection is due in the overwhelming majority of instances to the introduction

of pathogenic organisms into wounds of the genital canal including the placental site ; there may be a few exceptions to this rule, but they do not impair its general force. Under ordinary circumstances surgical cleanliness in obstetric work cannot be attained without the free use of antiseptics ; it is probable that ' aseptic ' midwifery will always be restricted to lying-in institutions. The great majority of women will no doubt at all times prefer to give birth to their children in their own homes, where circumstances are usually unfavourable to the organisation of the innumerable details of aseptic work.

Preparations.—The greatest care must of course be taken in preparing instruments, catheters, douche tubes, etc., before use. These and other obstetric instruments such as forceps can conveniently be boiled immediately before use in the patient's room in the obstetric steriliser shown in Fig. 170. This appli-

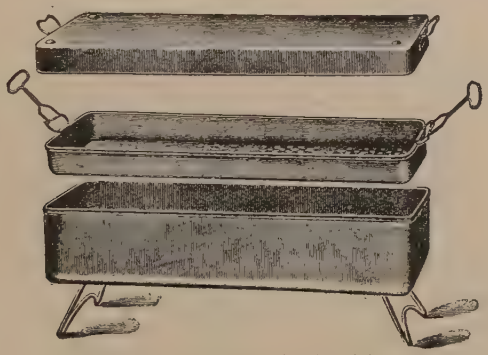


FIG. 170.—Obstetric Steriliser.

ance is made of suitable length to take the usual obstetric instruments, and can be carried in a bag of ordinary size. Before use they must then be taken carefully from the steriliser and *immersed* in a solution of carbolic acid 1 in 40, out of which they should be taken only for immediate application. Catheters and douche nozzles should always be boiled immediately before use.

The *vulva* always requires disinfection ; in the case of cleanly persons this is comparatively easy ; in women whose habits and surroundings are uncleanly it may be very difficult, so that the vulva becomes a definite source of possible infection. It would, without doubt, be an advantage in all cases to shave and disinfect the vulva as for a surgical operation, but if this is not done it should be shaved under anæsthesia before performing any of the obstetric operations. Whether shaved or not, the vulva should be well cleansed with soap and water, then with fresh water, and finally thoroughly swabbed with an

antiseptic solution ; for this purpose carbolic acid (1 in 40) or one of the coal-tar products such as lysol (1 in 160—*i.e.*, a teaspoonful to a pint) is preferable to mercurial solutions, for frequent swabbing is required during labour, and the mercurial solutions when freely used cause a good deal of irritation of the mucous surfaces. When any operative procedure is undertaken the vulva and vagina should both be disinfected by thoroughly swabbing them with tincture of iodine. Only perfectly clean and fresh linen, or clean pads of absorbent wool, should be allowed, after the external genitals have been disinfected, to come in contact with them. Sets of sterilised swabs, coverings, and towels, prepared for use during labour, can be obtained from surgical instrument makers. The *hands* and *forearms* of the medical attendant and the nurse should first be scrubbed for five minutes in hot water and soap with a *boiled* nail-brush, then the soap rinsed off in fresh hot water, and the hands finally immersed for two to three minutes in a solution of 1 in 1,000 biniodide or perchloride of mercury or in methylated spirit. It is almost superfluous to point out that it is impossible to sterilise the hands without first removing the coat, turning the shirt-sleeves up above the elbows, and removing rings from the fingers. If the hands have recently been infected from contact with a septic midwifery case or a suppurating wound, especial care must be taken, for it is well known that skin actually infected with pathogenic organisms is extremely difficult to sterilise, and the usual process should be repeated two or three times. Rubber gloves, previously boiled for ten minutes, should always be used in conducting labour. After sterilised rubber gloves have been put on, contact with all unsterilised objects must be rigidly avoided, and the greatest care and watchfulness are necessary to avoid touching blankets, sheets, etc. Yet unless these precautions are completely carried out there is little advantage gained by using the gloves at all. In the case of patients suffering from infectious discharges, whether of specific or septic origin, sterilised gloves should always be worn not alone in the patient's interest, but also to protect the hands of the attendant from infection, and thus render it practicable for him to attend other patients with safety. Those who attend midwifery cases should make it a rule to abstain from touching with the unprotected hand anything capable of conveying infection.

It will be observed that this technique falls short in some respects of that considered necessary for surgical operations. Strict surgical technique would require complete shaving and disinfection of the vulva before delivery, and the provision of a large and costly supply of sterilised dressings, towels, coverings, etc. This again would necessitate the provision of hospital accommodation for all confinements among the

poorer classes of society. For a normal confinement such elaborate technique is unnecessary, because internal manipulation can be reduced to a minimum; but when operative interference of any kind is required, the fullest surgical technique is a necessity.

It must be remembered that clothing also becomes infected by contact with septic discharges, and possibly also by exposure to the atmosphere of an ill-ventilated room in which a septic case is lying. Therefore, in the case of an obstetric nurse who has attended a septic case, the disinfection of her clothing becomes a matter of the greatest importance, and it is the duty of the medical man under whom she works to see that these precautions are carried out. All washable articles should be boiled; the others should be sent to the local sanitary authority, by whom they will be efficiently disinfected by heat. What is requisite for the nurse is also requisite for the medical attendant, although the danger in his case is less because he is not exposed to the risk of contact with septic material for such a long period as the nurse. A complete change of clothing is, however, absolutely necessary before passing from a case of infectious fever, of puerperal or surgical infection, or of suppuration of any kind, to one of normal labour. When a septic case has been examined without gloves being used, repeated disinfection of the hands must be carried out, and thereafter gloves used for all purposes; it is well recognised that skin which has been exposed to contamination by virulent bacteria is exceptionally difficult to sterilise. If these precautions are taken, it is not necessary for the medical attendant or the nurse to be suspended from obstetric work for a longer period than is required for the due performance of the various steps in disinfection; mere abstinence from work and lapse of time (although the latter may diminish the virulence of organisms deposited upon skin or clothing) are not disinfecting agents; they cannot be relied upon alone, and if other methods are efficiently practised they are unnecessary.

Of the many antiseptic substances employed in surgery, there is a general consensus of opinion that the mercurial salts are the most reliable for the disinfection of the hands. Biniodide is preferable to perchloride of mercury, because it is a slightly more powerful germicide, does not roughen the skin when frequently used, and does not coagulate albumen, nor corrode steel instruments. The bactericidal action of a solution of biniodide of mercury is increased by an admixture of alcohol in the proportion of three parts of solution to one of methylated spirit. The vulva, vagina, and cervix can be most efficiently disinfected by swabbing them thoroughly with tincture of iodine; antiseptics are, however, quickly washed off by overflowing blood or liquor amnii. Rubber, glass, or metal instruments should all be sterilised by boiling.

The subject of vaginal douching will be most conveniently considered when dealing with the puerperium (p. 493), but it may be stated here that douching is unnecessary before or during labour in a normal case when the vaginal canal is healthy. When the membranes rupture, and again when the body of the fœtus escapes, the passages are flushed from above with a large quantity of sterile fluid (the liquor amnii), which serves all the mechanical purposes of a douche and has none of its attendant risks.

The presence of a purulent vaginal discharge during labour may be a source of serious danger to the mother in causing puerperal infection, and to the child in causing ophthalmia.

Fig. 171.—The Abdomen of a Pregnant Woman at Term.

Such discharges will of course be recognised during pregnancy if the patient is examined, as has been advised, a few weeks before labour is due. Careful investigation is called for to determine whether gonorrhœal infection is present or not; the urethra, the Bartholinian ducts, and the cervix should be carefully inspected, and a bacteriological examination made of the discharge if the appearances are suspicious. Every effort should be made to cure all local infective conditions of this nature before labour is due.

II. **Diagnosis.**—The first examination of a woman in labour should be directed to the recognition of the three following points, which are of great practical importance: (1) the presentation and position; (2) the relation between the size of the fœtal head and that of the pelvis; (3) the presence of the fœtal

heart-sounds. These matters must be settled at the beginning of labour, and accordingly the examination should be made as early in labour as possible, unless the medical attendant has taken the precaution, advised on p. 93, of making the diagnosis of these points during the latter part of pregnancy. Only by this method can causes of obstruction be recognised in time to avoid the serious maternal and fœtal dangers to which they give rise when their presence is not detected until labour is advanced.

FIG. 172.—Abdominal Palpation. Step I. Palpating the Head by the *first pelvic palpation.*

The signs which indicate that labour is actually in progress have been already described (p. 209).

Abdominal Palpation.—Nearly all the information required at this stage can be obtained by examination of the abdomen ; it is entirely without risk and causes no discomfort, and it may accordingly be freely employed. A certain amount of skill, which can only be attained by practice, is necessary, and the details of palpation are much more readily learned during pregnancy, when the uterus is quiet, than during labour, when it is actively contracting ; the student should therefore miss no

opportunity of practising this method during the later weeks of pregnancy.

The patient should lie upon her back with the shoulders slightly raised, the knees slightly bent, and the abdomen completely uncovered. The hands should be warm, and should be used with gentleness; if labour is actually in progress, the manipulations should be suspended during the pains. The level of the fundus should first be noted; it will usually be found about a hand's breadth below the tip of the ensiform cartilage. The parts of the body of the fœtus which can be recognised by palpation are the head, the breech, the back, the anterior shoulder, and the folded limbs lying upon the ventral aspect. In normal labour the head lies in the lower uterine segment and the breech at the fundus, and this is the only arrangement with which we are here concerned. The lower pole of the fœtus should first be palpated by placing the hands flat upon the lower part of the abdomen, in the position shown in Fig. 172; the finger-tips are then directed downwards and inwards, and steady pressure is made so as to force them towards the pelvic brim, and at the same time approximate them to one another. This is called the *first pelvic palpation*, and by it, in a vertex presentation, the head of the fœtus may be grasped between the two hands and its distinctive characters made out.

It is not in all cases equally easy to feel the head distinctly. Thus in a primipara the greater part of the head has usually descended into the pelvic cavity, so that very little of its surface is accessible to the touch of the finger-tips. It is then said to be *engaged*, by which it is meant that the long diameter of engagement is below the plane of the brim; when the head is engaged it is fixed and cannot be moved from side to side, and the finger-tips cannot be pressed beneath it and displace it upwards. In a multipara the head is usually not engaged early in labour, and lies at a higher level, so that a better impression of its shape and outlines can be obtained. It can then be readily moved from side to side, and the finger-tips can be pressed below it and displace it still further upwards from the region of the brim. In all cases it can be recognised that the head forms a mass of densely hard consistence. Usually the patient experiences distinct pain on pressure over the head, but not over any other part of the body of the fœtus.

Before the head has descended too deeply into the pelvis its oval shape can be recognised, and also the direction in which the long diameter lies; usually also the sincipital and the occipital ends of the head-ovoid can be discriminated. Before labour has set in the long diameter of the head is not infrequently found to occupy the transverse diameter of the pelvic brim; when labour is actually in progress it will be found usually in one of the oblique diameters. The sincipital end of the long

diameter is broader, more prominent, and more irregular in outline than the occipital end ; but it is only in cases in which the conditions are favourable for palpation that these latter points can be made out. The head can be distinguished from the breech at the pelvic brim by the following points :—It is harder than the breech, better defined in outline, and is separated from the trunk by a groove corresponding to the neck ; by firmly drawing the fingers upwards from the head to the trunk the presence of this groove can usually be determined. When the head lies above the level of the plane of the brim at this stage of labour it can be more easily grasped, and may then be

FIG. 173.—Abdominal Palpation. Step I. Palpating the Head by the *second pelvic palpation.*

better felt by the *second pelvic palpation*, in which the ulnar margin of the hand is placed upon the pubes, and the thumb and fingers spread so as to include the head between them (Fig. 173). It will be evident that the *second pelvic palpation* will be more useful when the head is high, the *first pelvic palpation* when the head is low. In the former case the head can be readily moved from side to side ; in the latter case, as it lies in the pelvic brim, it is almost immovable.

The fundus of the uterus is next palpated with the two hands laid flat upon it (*fundal palpation*), the observer reversing his position so as to stand facing the patient (Fig. 174) ; the breech in this position will be felt to be larger, softer, and more irregular in outline than the head ; one buttock can often be felt as a firm,

distinctly rounded prominence. The buttock is, however, much smaller than the head, and can often be felt to rotate beneath the fingers as the trunk of the fœtus moves spontaneously round its vertical axis. Small rounded prominences representing the feet are usually to be felt in the same region as that in which the buttocks lie ; there are, however, certain exceptions to this statement (p 331). These small parts can be readily displaced

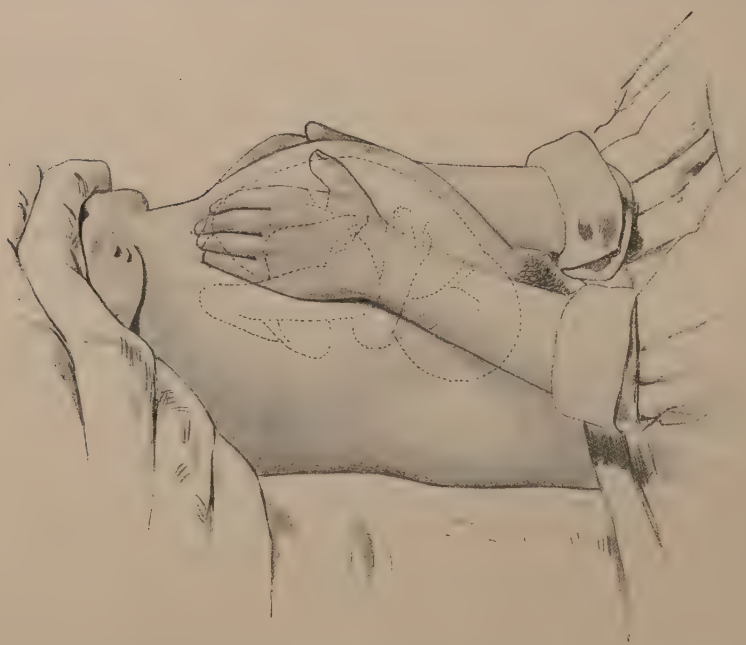


Fig. 174.—Abdominal Palpation. Step II. Palpating the Breech by the *fundal palpation.*

by the observer, and can often be felt to make vigorous spontaneous movements.

The front and sides of the uterus are next to be palpated (*lateral palpation*) in order to locate the back and the limbs (Fig. 175). It will be remembered that the head engages in one or other oblique diameter of the brim ; in the first and second positions a large area of the back is accessible to palpation ; in the third and fourth positions, however, only a small part of the back is accessible, while the limbs will be readily felt (Fig. 147). These differences in the disposition of the fœtal parts result in a certain difference in the shape and outline of the uterus which can often be observed on inspection. Thus in anterior positions the anterior abdominal wall forms a boldly marked

convexity of uniform outline, while in posterior positions it is distinctly flatter, and in thin subjects it is irregular in outline over the position of the folded limbs. Also irregularities of outline corresponding to the limbs can often be observed at one or other side of the uterus in an anterior position. On palpation the back forms an extensive, smooth, rounded area, over which the fingers pass without interruption. The limbs, on the other hand, are felt as irregularities, or as definite knobs, which can

FIG. 175.—Abdominal Palpation. Step III. Palpating the Back and Limbs by the *lateral palpation.*

be displaced by the fingers, and which can also often be felt to make spontaneous movements. In anterior positions the back appears to occupy the greater part of the uterus, while the limbs are only to be felt well to one or other side of the mid-line. In posterior positions the back may not be definitely recognised at all, while the limbs are recognisable on *both sides of the mid-line.*

The position of the anterior shoulder should also be sought. It forms a well-marked prominence in the lower part of the uterus a little above the head (Fig. 175) and will be found to

the right of the middle line in second and third positions, to the left in first and fourth positions ; it is nearer the middle line in anterior than in posterior positions.

It will now be apparent that it is possible to make a complete diagnosis of presentation and position from abdominal palpation alone. Thus the head is in the pelvic brim—*vertex presentation ;* the back is readily felt—*anterior* (*first or second*) *position ;* in addition, the limbs are to the right of the middle line—*first position ;* or the back cannot be located, but the limbs are readily felt—*posterior* (*third or fourth*) *position.* It

FIG. 176. -Showing the usual Position of the Point of Maximum Intensity of the Fœtal Heart-sounds in a Case of Second Position of the Vertex.

must, however, be recollected that the four ' positions ' of the vertex recognised in the British system of teaching are not the only positions in which the head may lie. It may take up an intermediate position between the first and fourth, or between the second and third, and also, though more rarely, between the first and second. Cases will, therefore, occur in which the exact location of the head cannot be defined as belonging to either of the four recognised ' positions.'

Auscultation of the fœtal heart also yields valuable information in diagnosis ; not only does it indicate presentation and position by the locality over which it is audible, but when heard it also proves that the fœtus is living, while by the changes

which it undergoes during labour timely warning of danger may be given.

The fœtal heart-sounds can best be heard by using a single wooden stethoscope, with a wide-mouthed transmitting end, and pressing it firmly against the abdominal wall over the back of the fœtus (Fig. 176). The part of the fœtal back over which the heart-sounds are best heard is the scapular region. The position occupied by this area in relation to the mother's

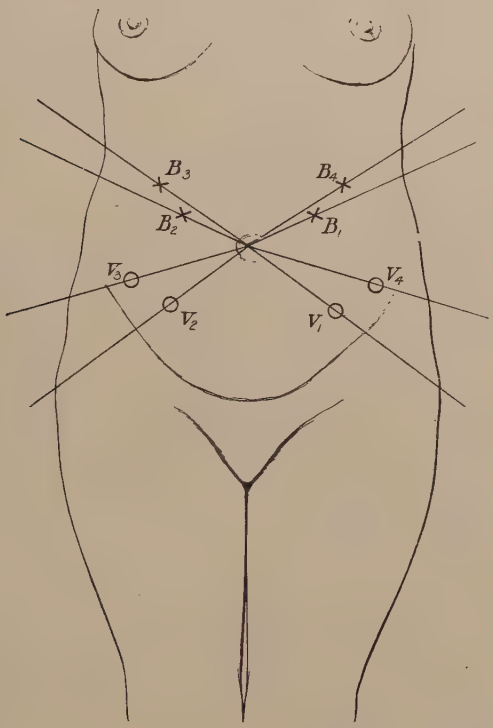


FIG. 177.—The Points of Maximum Intensity of the Fœtal Heart-sounds in Vertex and Breech Presentations.

V = vertex presentation. B = breech presentation.

abdominal wall varies with both presentation and position (see Figs. 145 to 148), and the stethoscope must be moved from place to place until the point of *maximum intensity* of the sounds has been located. Often they can be heard over a wide area of the abdomen, and it is then important to fix the point at which they are loudest. In the first position of the vertex the heart-sounds are heard best at a point about midway between the umbilicus and the left anterior superior iliac spine. This point corresponds almost exactly to the position of the left scapula,

i.e., the point on the fœtal body at which the heart-sounds will be most clearly heard. In the second position the point of maximum intensity is less definite. Often it is in the middle line, half-way between pubes and umbilicus ; almost as often it is somewhere about the centre of a line drawn from the umbilicus to the right anterior superior spine. In the third position the sounds are usually best heard at a slightly higher level, but further from the middle line towards the flank ; occasionally, however, they will be best heard in the mid-line, rather nearer the umbilicus than the pubes. When heard in the latter position there is probably sufficient extension of the trunk to throw the chest forwards against the anterior uterine wall. In the fourth position it is more difficult to find the heart-sounds than in any other. When heard they are usually found well outwards towards the left flank. When palpation fails to settle the diagnosis of position, it is clear that valuable aid can be obtained by localising the point of maximum intensity of the fœtal heart-sounds.

The *rate* of the fœtal heart-sounds at term varies from 120 to 140 per minute ; sex has no influence upon the rate, nor has size, although some observers believe that a large child has usually a slower heart-beat than a small one. The fœtal heart-rate is slowed during the uterine contractions, but quickly recovers when they pass off. Progressive slowing of the rate during prolonged labour indicates that the fœtus is suffering from the effects of pressure, and forms an indication for rapid termination of labour. Undue rapidity is also an unfavourable sign. If the rate in the intervals between the contractions falls below 100 or rises above 160, danger to the fœtus is certain. It is accordingly of importance to count as well as to locate the fœtal heart-sounds.

Vaginal Examination.—This method must be employed as little as possible during labour, owing to the attendant risks of infection. Vaginal examination is attended by a double risk. The first is the direct introduction of bacteria on the examining finger ; this risk can be overcome by thorough disinfection of the hands and the use of sterile rubber gloves. The second is the transportation by the finger of bacteria from the vulva and vagina to the cervix ; this risk cannot be completely overcome, because it is impossible to sterilise the vulva and vagina. Nearly all the information required can be obtained, as we have seen, by abdominal examination alone, and in normal labour vaginal examination for diagnosis is usually unnecessary. It may, however, be required to determine the onset of labour, or to watch the process of dilatation of the cervix.

In making a vaginal examination of a parturient or lying-in woman, the medical attendant should first disinfect his own hands and then the vulva of the patient, if no nurse is present

to do this. The hands are then again immersed in the antiseptic solution and sterile gloves are drawn on ; then, while the fingers of the left hand separate the labia, the index finger of the right hand is carefully passed into the vagina, avoiding all contact with the vulval hair, the patient's clothing, or bedclothes (Fig. 178). In making the examination the hands should be used dripping wet with the antiseptic solution ; no unguent is necessary, for the wet fingers will not cause the patient the least discomfort ; and it is well known that the so-called antiseptic unguents possess no bactericidal properties, and may even be a source of danger, for in some of them bacteria in a living state may exist for a long time. When it is necessary to

Fig. 178.—Vaginal Examination in the Dorsal Position. The Labia are held apart by the Fingers of the Left Hand while the Right Index and Second Fingers are passed into the Vagina.

repeat the examination the hands must again be disinfected, and the vulva swabbed with the antiseptic solution.

For a vaginal examination during labour the usual British practice is to place the patient upon her left side, and in this position also women are usually delivered (Fig. 179). The dorsal position, both for making vaginal examinations and for delivery, has many advantages, and will, no doubt, in time be generally adopted. In making the first vaginal examination certain

definite objects must be kept in view, and systematically dealt with one after the other ; unless this is done no information of value may be obtained, or the student may find it necessary to repeat the examination in order to determine something he has forgotten, and this needlessly increases the risks. The points should be observed in the order stated : (1) the level at which the head lies in the pelvis ; (2) the size of the dilating cervix and the condition of its walls ; (3) the presence or absence of a bag of waters ; (4) the position of the posterior fontanelle (if possible).

The *level* at which the head lies during the first stage of labour is different in a primigravida and a multigravida. In the former, if the conditions are normal, the head is low enough to

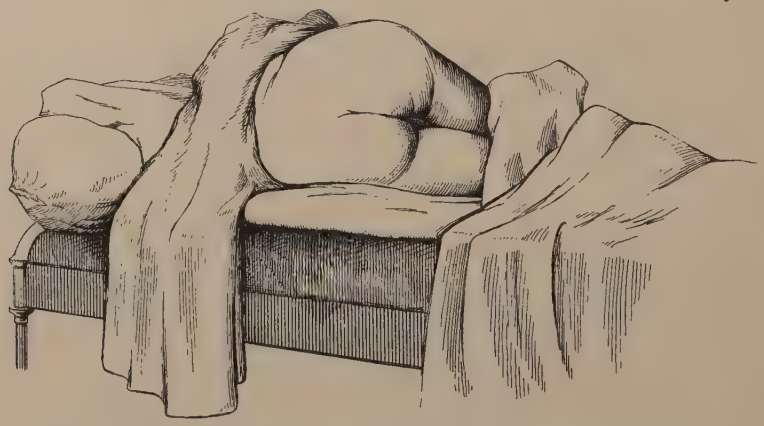


FIG. 179.—The Left Lateral Position. Patient prepared for Vaginal Examination.

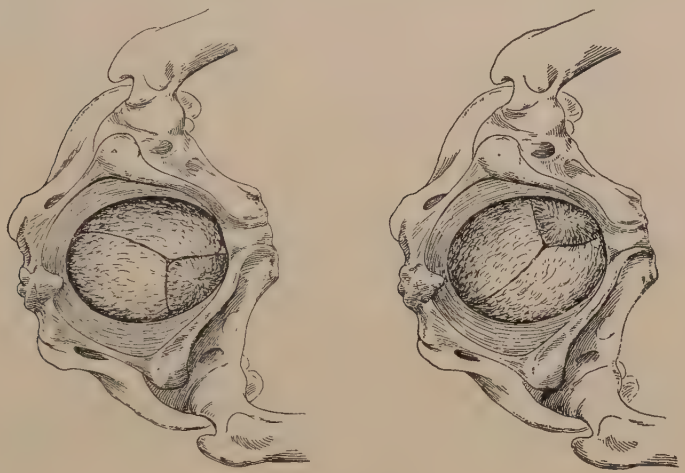
be readily felt by the finger in the vagina without making upward pressure to reach it. This signifies that the head is 'engaged' in the brim, *i.e.*, the greatest circumference of the head corresponds with the brim, while the vertex is in advance and therefore lies lower. If in a primigravida the head cannot be thus readily felt, suspicion is at once aroused that some cause of *obstruction* is present. The 'engaged' head has little mobility, but can be pushed upwards to a slight extent during the intervals between the pains.

In a multipara the head usually lies above the brim, and is not 'engaged' until the end of the first stage. It can then be felt only by making upward pressure with the finger, and it will be found to be freely movable during the intervals of the pains.

The walls of the *cervix* and the margins of the external os should feel soft and yielding to the touch ; during a pain the

margins of the os may become stretched tightly over the head, but in the intervals they are quite soft. In a primipara the cervix may become completely 'taken up' before the os is one-third or one-half dilated; the os then appears to the examining finger as a circular aperture in the tightly stretched cervical wall. In a multipara delay in dilatation of the external os is seldom observed.

The *bag of waters* may escape notice altogether unless the examination is continued during a pain; in the interval it does not bulge, the membranes lying in contact with the head. If



a *b*

FIG. 180.—*a*. First Vertex Position, showing Relations of Posterior Fontanelle and Sagittal Suture. *b*. Second Vertex Position. (Modified from Ribemont-Dessaignes and Lepage.)

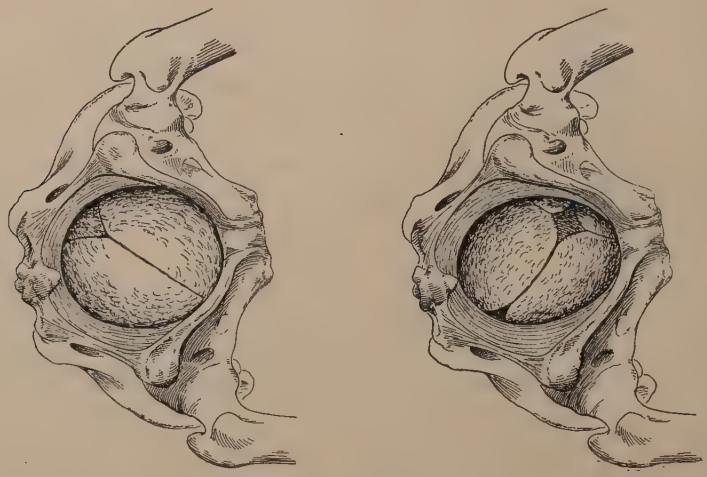
Patient in left lateral position.

the hairy scalp can be recognised by the finger it is obvious that there is no bag of waters.

The *posterior fontanelle* will be detected if the head is well flexed, as explained below.

While the cervix is undilated and the membranes are unruptured, the sutures and fontanelles cannot be distinctly felt, and great care must be exercised in avoiding accidental rupture of the bag of waters. Diagnosis of position by vaginal examination must usually be postponed until the second stage, when the necessary particulars can be made out without difficulty. In the *first* position the posterior fontanelle will be felt in the left anterior quadrant of the pelvis; the sagittal suture runs backwards and to the right in the line of the right oblique diameter, and the anterior fontanelle is out of reach (Fig. 180, *a*). When

internal rotation has occurred, the posterior fontanelle will be found in the middle line anteriorly. The disposition of the sutures and fontanelles in the second position is shown in Fig. 180, *b*. In the case of the posterior positions, the degree of flexion present influences the disposition of the sutures and fontanelles to a considerable extent ; when the head is flexed, the posterior fontanelle can be felt in one or other posterior quadrant of the pelvis, the anterior fontanelle being out of reach (Fig. 180, *a*). If, however, flexion is deficient, the anterior fontanelle comes within reach and can be felt in the anterior quadrant of the pelvis, while the posterior fontanelle can barely



a *b*

FIG. 181.—*a*. Third Vertex Position, Head flexed. *b*. Fourth Vertex Position, Head partly extended, showing Anterior and Posterior Fontanelles and Sagittal Suture. (Modified from Ribemont-Dessaignes and Lepage.)

Patient in left lateral position.

be reached at all (Fig. 180, *b*). Sometimes difficulty arises in the second stage owing to the formation of a large caput succedaneum which obscures the sutures and fontanelles. The best guide to position then is the ear, which can easily be reached when the head is low ; the curve of the helix is towards the occiput.

Rectal examination.—The risks of infection attendant on vaginal examination have been mentioned. Rectal examination during labour must be regarded as an important prophylactic measure against infection ; it possesses nearly all the advantages of vaginal examination and none of the disadvantages. It enables the level of the head in the pelvis and the degree of

dilatation of the cervix to be easily felt ; and, with practice, the sutures and fontanelles, and the bulge of the bag of waters, can be distinguished. Since rectal examination is without risk it can be repeated as often as is desired, and it possesses the additional advantage of not requiring disinfection of the patient or of the attendant's hands. A glove is drawn over the hand and the well-lubricated index finger is passed into the rectum. The glove, after use, is washed and boiled and is kept specially for rectal examinations ; on no account may the glove be used for vaginal examinations. Vaginal examinations need only be made in those few cases where rectal examination has failed to give satisfactory information.

Diagnosis of the Progress of Labour.—The duty of the doctor during the first and second stages of labour is only that of watching. Strictly speaking, these stages do not require 'management' in a normal case, and the less done the better. But in labour the transition from normal to abnormal conditions may take place at any moment, and trained observation is accordingly necessary. The actual wants of the patient may be attended to quite as well by a nurse as by a doctor during the first stage. The patient may be allowed to walk about, or sit, or assume any position in which she is for the time easier. An enema should be given as soon as labour has definitely begun, and should be repeated if necessary to ensure the rectum being empty at the time of the delivery of the head. Evacuation of the bladder is usually frequent and spontaneous. Nourishment may be given freely, and often the patient can take her ordinary meals. Vomiting may occur in this stage, but it is neither unusual nor important.

While regular progressive pains continue it may be taken that labour is proceeding satisfactorily, and vaginal examinations are unnecessary. It is, however, necessary for students to learn by examination what are the normal conditions, or they cannot recognise the occurrence of the abnormal. The earliest change observed is that the cervix is 'taken up,' *i.e.*, the projection of the vaginal portion disappears. In a primigravida the dilating cervix now becomes tightly stretched by the advancing vertex, so that during a pain the ring formed by the os externum may be felt to be firm and well defined, the bag of waters bulging through it ; in the intervals the head recedes, the os externum becomes relaxed, and the bag of waters collapses. Progress is recorded by noting the size of the os externum, as :— 'admitting one finger,' 'two fingers,' 'half dilated,' or 'three-fourths dilated.' When fully dilated the anterior lip is still felt between the pubes and the head, but the posterior lip will have disappeared, as it has been drawn up out of reach. It must be repeated that it is unnecessary and undesirable to make repeated examinations during the first stage to ascertain the

size of the os. If the pains are steady, intermittent, and progressive, *i.e.*, increasing in length and severity, we know that, given normal local conditions, the labour is proceeding satisfactorily. A slight discharge of blood-stained mucus (from the cervix) is usually seen during the first stage.

The transition from the first stage to the second is marked by two phenomena recognisable without internal examination, viz., (1) rupture of the bag of waters and escape of a variable amount of liquor amnii ; (2) succeeding this, a gradual change in the character of the pains, which become expulsive or 'bearing down,' from participation of the voluntary muscles of expiration. Examination made at this period will allow the hairy scalp to be recognised by the finger, and the sutures and fontanelles to be more readily felt, thus confirming the diagnosis of position. The escape of a large quantity of liquor amnii sometimes carries down with it a loop of the umbilical cord (see "Prolapse of the Cord," p. 360), and if an internal examination is not made at this period the accident may remain unrecognised. The change in the character of the pains is not immediate, and in some cases voluntary expulsive efforts are never properly developed ; the patient does not appear to be able to 'bear down.' Such patients are usually of nervous type, and lose control of themselves during the severe pains of the second stage. Patients under the influence of narcotics during labour also lose to a great extent the power of making voluntary expulsive efforts.

During the second stage the patient must lie down ; the medical attendant cannot leave her except for a very short time. The pains of this stage are severe, and the voluntary efforts of the accessory muscles exhausting. The patient should, however, be encouraged to continue as long as possible without anæsthesia, as voluntary bearing-down efforts greatly assist the descent of the head. The fœtal heart should be auscultated every fifteen minutes when the second stage is unduly prolonged, in order to detect impending asphyxia, the most important sign of which is slowing of the fœtal heart-rate in the intervals between the contractions (see p. 284). If the patient is lying on her side she will have to be turned on her back for this purpose, whereas if the more convenient dorsal position has been adopted for delivery, the heart can be auscultated without disturbing her. It is a good plan to mark on the abdomen with a dermographic pencil the point of loudest intensity of the sounds ; they can then be located with greater ease on subsequent auscultations.

On *vaginal examination in the second stage* the head has usually descended sufficiently to allow the whole area of the presenting part to be reached by the finger. First the lip of the os externum should be sought ; the anterior portion alone will

be felt, and its condition should be noted ; not infrequently it becomes swollen from œdema induced by compression between the head and the pubes ; normally it is felt as a soft, thick fold of tissue. By sweeping the finger-tip round the presenting part the os will also be felt at the sides and behind, if it is incompletely dilated. Next the condition of the scalp should be noted ; a small caput may be detected, the pitting of the tissues on pressure being recognisable by touch. A large caput at this period of the second stage is abnormal and indicates some degree of obstruction. Next the sutures should be sought for and special attention paid to the points where sutures can be felt to meet; these positions correspond to the fontanelles, and usually only one is within reach. The distinction between the anterior and posterior fontanelles is by no means so easily made during labour as upon the fœtal skull. The bones are compressed, and the size of the fontanelles is considerably reduced. Further, if the fontanelle is not readily accessible an erroneous impression may be produced by feeling only a portion of it ; thus if the anterior fontanelle is difficult to reach so that only one corner of it is felt, three sutures only may be discovered, and in consequence it may be mistaken for the posterior. During labour the depression of the occipital bone beneath the parietals is exaggerated by compression so as to deepen the floor of the posterior fontanelle and throw up the edges of the parietal bones to an unmistakable degree. In the case of the anterior fontanelle the bones are on a more uniform level, and this point is therefore one of great diagnostic importance. After satisfactorily recognising the fontanelle an attempt should be made to define its position in the pelvis, and for this some experience is required. When the posterior fontanelle is felt it usually lies in the anterior half of the pelvis at this stage of labour, and inclined slightly to one or other side. Later on in labour, after internal rotation has occurred, it will be found in the middle line, behind or beneath the symphysis. The anterior fontanelle is seldom felt except in occipito-posterior positions.

III. **Narcosis and Anæsthesia in Normal Labour.**—Attention has been directed in recent years to the use of methods of producing continuous narcosis during labour, the objects aimed at being to relieve or entirely to eliminate the sufferings of the mother, and also to destroy her subsequent recollection of the proceedings ; in short, the object is to produce analgesia during labour, and amnesia afterwards. These results can be obtained by the combined administration of morphia and scopolamine or hyoscine, in repeated doses, after the method worked out by Gauss of Freiburg, who also invented the rather fanciful name by which it has become known to the public through the activities of journalists, viz., ' twilight sleep ' (German *Dämmer-*

schlaf). In this country the method has recently been carefully investigated by a Committee of the Section of Obstetrics and Gynæcology of the Royal Society of Medicine, and their conclusions deserve general acceptance. They found it possible to produce an almost painless labour in rather less than half the cases treated, and considerable diminution of suffering in all but 5 per cent. of the total. There are, however, certain disadvantages and some risks both to the mother and the fœtus.

The *disadvantages* are that—(1) labour is prolonged in all its stages, most markedly in the second stage, owing to the suppression of voluntary muscular contractions ; (2) in consequence delivery by forceps becomes necessary in a high proportion of cases, varying from 12 per cent. in one hospital to 32 per cent. in another : a general anæsthetic is then necessary ; (3) the high forceps rate involves a slight increase in puerperal morbidity ; (4) the patient needs continuous watching during the first stage by a nurse who has been specially trained in the use of the method, and very frequent visits by the doctor : the labour being prolonged, a second nurse may be required, and the doctor may have to remain continuously with the patient for several hours during the second and third stages. Occasionally active delirium occurs, necessitating further help to control the patient.

The *risks* are (1) fœtal apnœa or asphyxia, resulting from the absorption of morphia and paralysis of the respiratory centre, and which is most marked when a general anæsthetic has been administered as well ; (2) death of the mother from hyoscine or scopolamine poisoning, a few cases of which have been observed (Blacker).

Technique.—The drugs employed are morphia and hydrobromate of scopolamine ; they should be used in sterile solution, each dose being contained in a separate ampoule. An initial dose of gr. $\frac{1}{4}$ of morphia is used, and this is not repeated ; along with the morphia a dose of gr. $\frac{1}{150}$ of scopolamine is given, and afterwards a dose of gr. $\frac{1}{450}$ of the latter drug is administered every hour or every two hours according to the degree of narcosis produced. Individuals vary greatly in their susceptibility to the influence of these drugs, and the doses must be varied accordingly. The average number of injections required throughout labour was found by the Committee mentioned above to be about six or seven, but in one hospital the average number was from thirteen to fourteen, representing a total dosage of scopolamine in the first case of about gr. $\frac{1}{80}$, in the second of about gr. $\frac{1}{40}$. The first injection should not be given until regular pains, recurring at five-minute intervals, are proceeding ; this is a better guide than the degree of dilatation of the cervix. External stimuli are to be excluded as far as possible throughout the labour ; the room is darkened ; the

patient's ears are plugged; visitors are rigidly excluded; examinations are dispensed with altogether or reduced to a minimum. When sufficiently narcotised, the patient sleeps during the interval; she wakes up with the pain, which she may appear to feel acutely, and becomes often restless and difficult to control, sinking again to sleep when it has passed off. During the passage of the head the patient may become uncontrollable, and perineal rupture is abnormally frequent; she often recollects this part of the labour unless a general anæsthetic has been administered as well.

The *puerperium* is not adversely affected. The patient sleeps for some hours after delivery, and after a prolonged labour under narcosis there is usually a remarkable absence of the prostration which generally characterises such labours; the patient has no recollection of prolonged and severe suffering and may not indeed remember anything that occurred previously to her waking up with the baby beside her.

The second stage is that in which the greatest care and judgment are required. Delay may be overcome by the application of forceps under general anæsthesia. The fœtal heart-sounds must be carefully observed. Slowing of the rate indicates that the injection must not be repeated, and, if marked, that the labour must be terminated with forceps.

IV. **Uterine Stimulants in Labour.**—Two pharmacopœial remedies possess a definite power of increasing the activity of the uterus in labour, viz., ergot and pituitary extract (posterior lobe). The former is a remedy of long standing and general acceptance; the latter, though more recent, has now been fully tested from the clinical point of view.

Pituitary Extract (posterior lobe).—This is undoubtedly the most potent drug we possess for stimulating the activity of the uterine muscle. It has comparatively little effect on the *inactive* uterus, but upon the parturient uterus its effects are remarkable. Its action is very rapid; within two or three minutes of the injection the contractions become extremely powerful and are increased in duration and frequency. A few cases have been reported in which the uterus, instead of being stimulated into regular activity, has passed into a state of tonic contraction; but this is most unusual. Its action is temporary only, and lasts on an average from fifteen to twenty minutes. It is very important to use reliable preparations, the strength of which is standardised and known; the various preparations on the market vary greatly in activity.

A drug of such potency must be used with great caution. Many cases of rupture of the uterus have followed its use in unsuitable cases, and even in well-chosen cases this accident has occasionally occurred.

It should never be given during the first stage of labour, and

its use is absolutely contra-indicated in cases in which there is disproportion, however slight, between the head and the pelvis, or any other cause of obstruction to the easy birth of the head. Its use during labour should be confined to cases in which the head is delayed at the vulva on account of the uterine contractions being insufficient to overcome the resistance of the perineum. If in such cases the uterus is acting well its use is unnecessary and inadvisable ; but in cases of inertia (see p. 408), complete or partial, its effect is well seen, and by its use a forceps operation may be frequently avoided. In a multipara the effect of a single dose administered in the second stage is often to complete delivery within a few minutes.

A further advantage is that the separation of the placenta is usually accelerated, and the third stage is thus made shorter and easier to manage. In the third stage, or after labour, it may be given as an alternative to ergot for the purpose of ensuring complete uterine retraction.

The use of pituitary extract is not entirely without risk to the fœtus ; intracranial injury and hæmorrhage may be caused by the head being too rapidly forced by the powerful uterine contractions past a rigid vulva and perineum.

For the induction of labour, pituitary extract is used in conjunction with castor oil and quinine (see p. 597).

The dose is $\frac{1}{2}$ c.c. of ' pituitrin,' or $\frac{1}{2}$ c.c. of a 20 per cent. solution of pituitary extract ; the injection should be made deeply into the muscles of the outer side of the thigh.

The Action and Uses of Ergot.—In small doses ergot acts as a general hæmostatic, contracting the calibre of the peripheral blood-vessels ; this action is made use of in cases of slight bleeding from the uterus during pregnancy. In larger doses it exerts a specific effect upon the uterine muscle when in action. This effect is to increase the force, duration, and frequency of the uterine contractions and to stimulate retraction. In still larger doses the effect is intensified, and the whole uterine muscle passes into a condition of tetanic contraction. Ergot is unable, in any dose, to transform the contractions characteristic of pregnancy into those characteristic of labour ; therefore it is useless for inducing abortion or premature labour, and its specific effect is manifested only upon the parturient uterus. It is believed that ergot acts upon muscle by stimulating the peripheral nerve terminations.

It is found, clinically, that the action of ergot upon the parturient uterus is somewhat variable and uncertain, and this appears to be due to the difficulty of making uniform pharmaceutical preparations of the drug. Accordingly the effect is difficult to control, and there is great risk of producing tetanic contraction by its use, except in small quantity. Its use, therefore, in the treatment of uterine inertia during the

first and second stages of labour is absolutely contra-indicated. During the third stage it is best to withhold it until after the expulsion of the placenta for fear of inducing tetanic contraction. After the termination of the third stage, it is useful in multiparæ, in maintaining uterine contraction and promoting the expulsion of blood-clot from the uterus. Primiparæ do not, as a rule, require it after labour.

V. **The Delivery of the Fœtus and the After-birth.**—The work of the medical attendant may be said to begin when the head has reached the vulva, his duty being to control the passage of the head and body of the fœtus through the vulva, and as far

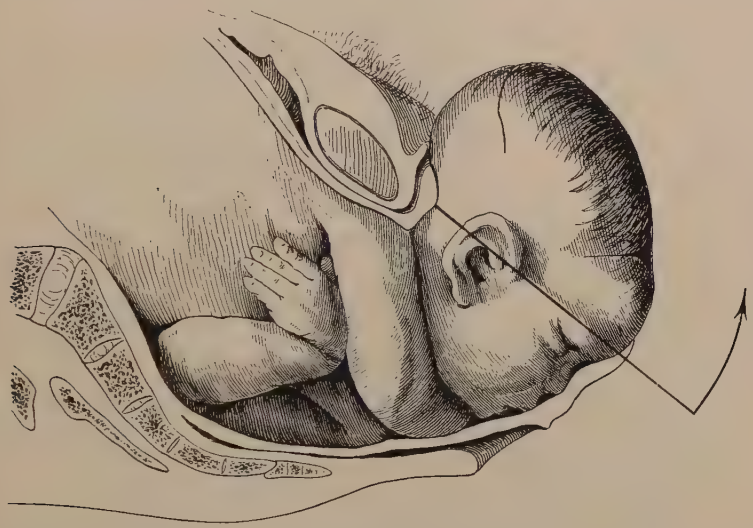


Fig. 182.—Extension of the Head (Third Movement) in passing the Pelvic Outlet; Sub-occipito-frontal Diameter engaged; the Bi-parietal Diameter is free. (Bumm.)

as possible to avoid injury to the pelvic floor. In this country women are usually delivered lying upon the left side, with the thighs partly flexed and the knees held apart by an assistant, but the dorsal position is equally convenient.

Time should be allowed for the actual expulsion of the head, especially in a primipara, or whenever the perineal body appears to be unusually resistant. If delivery is taking place under anæsthesia it will usually be observed that as the anæsthesia deepens the pains become weakened and delayed. Sometimes this effect is so marked with only slight anæsthesia that labour almost comes to a standstill and the administration of chloroform has to be stopped. During the delivery of the head rapid progress is, however, undesirable, and

the administration of chloroform may have to be pushed so as to produce surgical anæsthesia. It is usual to speak of the process of assisting the delivery of the head as 'supporting the perineum.' This expression is unfortunate, for attention should be mainly directed not to the perineum, but to the head ; no amount of support applied to the perineum will prevent a threatening laceration unless the movements of the head can be properly directed. The object in view is to deliver the occiput first, and to prevent extension of the head from taking place until the bi-parietal diameter is free from the vulva. This implies that the natural tendency to extension of the head at this stage must be resisted, up to a certain point. By making pressure upon the stretched perineum with the palm of the hand, and at the same time allowing the occiput to protrude beneath the symphysis, the head will be kept from extending until the wide posterior part (bi-parietal diameter) has escaped. The head may then be allowed gently to extend at the end of a pain, the edges of the stretched vulva being slipped over the face and chin during an interval. This method has a definite mechanical advantage. If the head does not extend until the parietal eminences are free, extension brings successively the sub-occipito-bregmatic, sub-occipito-frontal, and sub-occipito-mental diameters (each measuring about $3\frac{3}{4}$ inches) through the antero-posterior diameter of the outlet (Fig. 182). If, however, the head should extend before this, the occipitol frontal ($4\frac{1}{2}$ inches) or the occipito-mental (5 inches) diameters must pass through the outlet, or, if not these, then certain intermediate diameters necessarily longer than the sub-occipito-bregmatic and sub-occipito-frontal. It will thus be seen that the important point is not the support given to the perineum, but the attitude of the head when escaping from the vulva. In spite of all precautions, a certain amount of laceration almost always occurs in a primipara, and even when the perineal body seems intact externally there may be considerable laceration of the lower part of the posterior vaginal wall.

Sometimes the expulsion of the head is rapidly effected by a succession of violent pains, so that no opportunity occurs for controlling the mechanism. More often, and especially in a primipara, a gradual advance with each pain occurs, the head retreating completely in the intervals. Thus the vulva and perineal body are gradually stretched. Finally the head reaches a position in the outlet from which it shows little or no tendency to retreat during the interval, and it may then be maintained in that position by making pressure over the extended perineal body, while with the other hand the stretched vulval ring is slipped back over the parietal eminences. The head will then be easily freed by pushing forward the face and chin, which are still within the maternal canal.

In delivering an abnormally large head it may become evident that considerable laceration must occur. The direction

FIG. 183.—Illustrating the Delivery of the Shoulders; the Movement of Trunk Rotation has occurred, the Bis-acromial Diameter lying in the Antero-posterior of the Outlet.

of the tear may then be deflected from the mid-line by making two lateral incisions with scissors passing from $1\frac{1}{2}$ to 2 inches backwards and outwards so as to avoid the rectum. This procedure is known as *perineotomy* or *episiotomy* (see p. 406).

After the expulsion of the head has taken place, a pause in the uterine contractions occurs. The child's eyes should now be wiped with pledgets of cotton-wool soaked in boric lotion, and if the cord encircles the neck it should be pulled over the occiput and freed. If the pause is a long one, the face will become cyanosed from the pressure exerted upon the undelivered trunk. As soon as the uterus contracts again, the movement of external rotation will be observed, and when the bis-acromial diameter has entered the antero-posterior of the outlet, delivery of the body may be assisted by drawing the head *gently* forwards round the symphysis and making pressure with the other hand upon the uterine fundus (Fig. 183). In case of difficulty the index finger may be hooked into the axilla af the posterior shoulder, and traction thus made upon the trunk, *in the axis of the pelvic outlet.* If trunk-rotation does not occur spontaneously, owing to the absence of pains, the shoulders must be rotated before making traction on them ; severe laceration will be caused if the shoulders are pulled out in the oblique diameter. In order to secure proper retraction of the uterus, the hand must not leave the fundus during the delivery of the body of the fœtus, if the body is delivered by traction.

Delivery of the After-birth.—The labour has now entered upon the third stage ; attention will be given first to the condition of the uterus, and then to the division of the cord. The cord may be divided as soon as it has ceased pulsating, or earlier when respiration has been satisfactorily established. Two ligatures of twisted thread, previously boiled, should be applied, one about an inch and a half from the navel, the other an inch further away ; that on the fœtal side must be tightly tied with care, and the cord then divided with a pair of sterilised (boiled) scissors. Careful antiseptic precautions are required in ligaturing and dividing the cord on account of the danger of umbilical sepsis. The cut end of the cord should be touched with tincture of iodine, and the child then wrapped up in blankets and removed. The perineum should next be examined to note what laceration, if any, has occurred, and in so doing the vulva should be opened up with clean fingers, so as to bring the posterior vaginal wall into view. The patient should now lie upon her back, for in that position the uterus can be controlled much more easily and effectually than in the side position. Nothing should be done except gently to grasp the uterus with the hand until it is perceived that the placenta has been expelled from it ; when the uterus is felt to relax it should be gently massaged.

At the beginning of this stage the medical attendant should on abdominal examination carefully note the height of the fundus, the size, mobility, and outline of the uterus, and the presence of the usual slight supra-pubic hollow. All these points can be observed much more easily in the dorsal than in

the side position. By the changes which occur subsequently he will be able to recognise the detachment of the placenta. When separated from the uterine wall the placenta falls into the cervix or the vagina. In consequence the body of the uterus becomes smaller, harder, more globular and more movable. The level of the fundus also rises slightly, as the presence of the placenta below prevents the uterus from sinking into the pelvic cavity. For the same reason the supra-pubic hollow becomes replaced by a slight bulging, indicating the position of the placenta—*i.e.*, in the cervix. Further evidence of separation may be found in lengthening of the portion of umbilical cord which lies outside the vulva. When in doubt as to the position of the placenta, the uterus may be grasped and pushed gently downwards and backwards into the pelvis ; if the placenta is still attached to the uterus the cord will visibly descend with it and retreat when

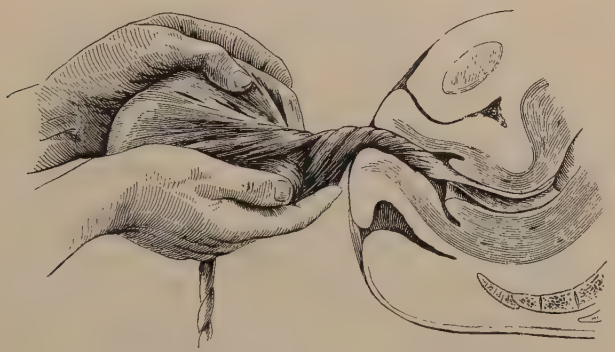


Fig. 184.—Delivery of the Membranes. (Bumm.)

the pressure is withdrawn. If separated, little or no effect will be observed.

When separated the placenta can usually be delivered by a voluntary bearing-down effort on the part of the patient, aided by the medical attendant grasping the uterus and pushing it downwards and backwards in the axis of the pelvic brim. When it is certain that the placenta has left the uterus, pressure upon the fundus may be aided by gentle traction upon the umbilical cord ; this must never be done, however, while the placenta remains attached to the uterus. When the placenta appears at the vulva, it should be received in the hands and rotated so as to twist the membranes which follow it into a spiral or rope, which gradually comes to an end and slips out without any traction having been made (Fig. 184). In this way tearing of the membranes, leading to retention of a portion in the uterus, is avoided.

If after waiting for at least half an hour it is found that the placenta still remains in the uterus, an attempt may be made to effect its expulsion by the manipulation of Crédé, often called 'expression of the placenta.' This consists in gently rubbing the uterus so as to bring about a firm contraction, and then compressing it strongly in the grasp of one or both hands, at the same time pressing the whole organ downwards and backwards into the pelvic cavity (Fig. 185). The partially

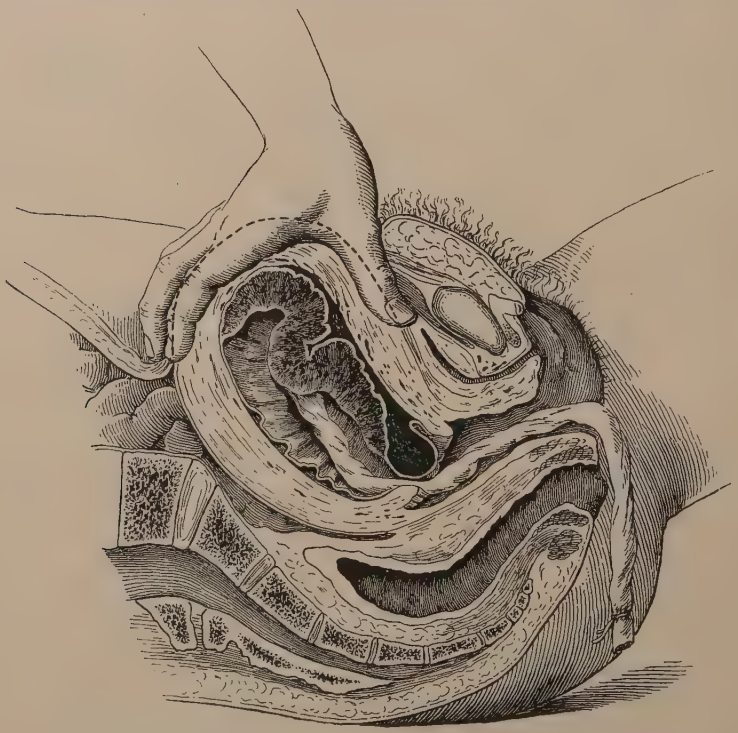


Fig. 185.—Expression of the Placenta. (After Crédé.)

detached placenta can in this way often be squeezed out of the uterus, but certain disadvantages always attend this manœuvre —viz., (1) portions of the placenta and of the chorionic membrane may be left attached to the uterine wall, being torn away from the bulk of the after-birth ; (2) if the uterus is thus compressed *during relaxation*, the process of inversion may be started (see p. 437). It must therefore be clearly understood that the Crédé method is not to be employed merely to save time, but only in cases where the spontaneous separation of the placenta is unduly delayed. With the aid of anæsthesia, the

placenta can always be delivered by this method, unless morbidly adherent, but the risk of retention of a portion of the afterbirth is naturally greater than when anæsthesia is not used.

Prolongation of the third stage, if not accompanied by considerable hæmorrhage, is not of itself disadvantageous to the patient. There is therefore no need for hurry, and it must be borne in mind that natural separation of the placenta is much to be preferred to its artificial removal, and is worth waiting for. If the placenta has not been fully separated in half an hour from the birth of the child, an attempt may be

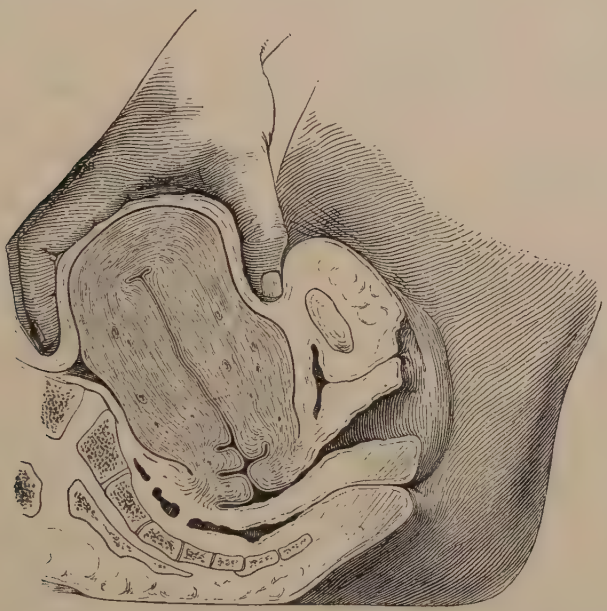


FIG. 186.—Compression of the Fundus in order to empty the Uterus after Delivery of the Placenta. (Edgar.)

made to deliver it by expression ; if unsuccessful, repeated attempts should be made at intervals. Unless an undue amount of bleeding occurs, manual removal of the placenta by passing the hand into the uterus (see p. 468) should not be undertaken until at least two hours have elapsed. Manual removal is a most dangerous operation, because of the risk of infection.

After a normal labour vaginal douching is unnecessary, but the nurse should thoroughly swab the vulva with an antiseptic solution (*e.g.*, 1 to 2,000 biniodide of mercury), and all perineal tears of $\frac{1}{2}$ inch or more must be immediately repaired. The methods of sewing up perineal lacerations are discussed on p. 677. The uterus should be continuously massaged for ten

to fifteen minutes after the delivery of the after-birth, and gently but firmly squeezed to expel any blood-clot that may have remained within it (Fig. 186). Persistence of hæmorrhage at this time is frequently due to the presence of a clot in the uterus, and when this has been squeezed out the bleeding immediately ceases. The presence of a clot in the uterus does not always cause bleeding, but it invariably interferes with the proper retraction of the uterus. The empty, fully retracted and contracted uterus feels densely hard in consistence, and irregular in outline ; when the uterus remains globular and bulky during a contraction, and softish in consistence, a clot is probably present. If a clot is allowed to remain in the uterus, although hæmorrhage may cease, the patient is liable to (1) severe after-pains ; (2) delayed involution ; (3) sapræmia. Should therefore the uterus tend to remain flabby, a dose of ergot may be given, either by the mouth in the form of liquid extract of ergot ʒj, or preferably by deep intra-muscular injection into the outer side of the thigh in the form of injectio ergotinæ hypodermica (B.P.) or ' aseptic ergot.' A useful alternative to ergot is pituitary extract, which may be given intra-muscularly in doses of 1 c.c. of a 20 per cent. solution. These drugs are seldom required by a primipara, but there is no objection to their routine use in multiparæ. Finally an abdominal binder should be firmly applied, and a sterilised absorbent pad placed over the vulva.

VI. **The Toilet of the Mother and the Child.**—When the labour has been thus completed the condition of the mother requires immediate attention ; and although this work is part of the nurse's duties, the doctor must see that it is properly done. The vulva must be thoroughly swabbed with antiseptic solution, such as biniodide (1 to 4,000) or lysol (ʒj to Oj), and all blood-stained or soaked clothing and sheets removed and replaced by dry and clean ones. A sterilised pad is placed in contact with the vulva to receive the discharges, but when delivery has been spontaneous and no infective local conditions are present, douching is unnecessary and inadvisable. The conditions under which douching immediately after labour is required will be considered on p. 475. When the mother is suffering from shock or exhaustion the toilet should be carried out as expeditiously as possible and without delay ; hot bottles properly protected, and hot fluids, such as milk or weak tea, are then administered and the patient kept lying flat upon her back. An abdominal binder should be applied either at once or later on ; this gives the patient a comfortable feeling of support. The binder should be cut to the shape of the body, being fixed with straps and buckles, and should extend from above the level of the umbilicus down to a point well below the level of the great trochanter. A roller towel fixed with safety

pins forms a useful domestic substitute. Before closing the binder the uterus should again be firmly rubbed with the hands. Finally the temperature and pulse are recorded. A pulse-rate of over 100 calls for care, but is not uncommon in cases where delivery has taken place without full anæsthesia.

General Management of the Infant.—When the child has been delivered in a healthy condition, pulmonary respiration is established almost instantly, and after a few ineffectual gasps the child cries lustily. Delay in breathing on the child's part may be overcome by lightly flicking or slapping its body, or by sprinkling tepid water on its face and chest. When breathing has been started the eyes should be again wiped with boric acid lotion (1 in 40) to free the lids from vernix caseosa, etc. ; if a purulent vaginal discharge has been present during pregnancy, a solution of 1 in 4,000 perchloride of mercury should be used for this purpose, and afterwards 1 or 2 minims of a 1 per cent. solution of nitrate of silver introduced into the lower eyelid with a dropper ; this procedure, introduced by Crédé, is a reliable prophylactic against ophthalmia neonatorum (see p. 562).

The infant's bath is usually undertaken by the nurse, but the medical man must see that the work is properly done. The amount of vernix caseosa varies greatly ; when there is a good deal it can best be removed by the use of warm olive oil and swabs of cotton-wool. Unless all vernix and adherent blood-clot are removed from the folds of the skin at the groins and axillæ, cutaneous irritation will afterwards be caused. The infant may then be placed in a bath of soap and water at a temperature of 100° F. The medical man must afterwards examine the child's body and make sure that no congenital defect is present, such as cleft palate (which would hinder suckling), hernia, undescended testicle, or imperforate anus ; the immediate recognition of the last defect is a very important matter, both for the credit of the doctor and the chances of survival of the child. After a difficult labour, the possibility of obstetric injuries to the head or limbs must be borne in mind. Occasionally an infant is born with one or two teeth already erupted ; they are usually central lower incisors. The position of the caput in head presentations may be noted for confirmation of the clinical diagnosis of position. It must, however, be borne in mind that its position tends to change after birth by gravity ; thus if the child is laid upon its side the fluid in the caput tends to gravitate to the dependent part of the scalp. The stump of the cord should be examined to make sure that the ligature is secure, and another applied if it has loosened ; then the cut surface is again painted with tincture of iodine, and a sterilised dressing applied so as to envelop it ; or the cord may first be dusted over with powdered boric acid, and then enclosed in boric lint. The nurse

must take the greatest care to keep the cord surgically clean during the process of shedding. The child should, if possible, be weighed before being dressed, and it is well to keep a regular record of its temperature, taken in the fold of the groin.

It is of great importance that the new-born infant should be carefully protected from cold ; weakly infants are especially susceptible to chill, the results of which are often serious. It should therefore be kept well wrapped up in a cot warmed with hot-water bottles ; the water used to fill the bottles must not be more than warm, and they must be placed *underneath* the blankets on which it lies, as burning is very readily caused by comparatively low degrees of heat in young infants.

Occipito-posterior Positions of the Vertex

The two posterior positions—third and fourth—taken together are much less frequent than the two anterior positions—first and second—the relative proportions being about 1 posterior to 3 anterior (see p. 254).

Mechanism.—It has already been pointed out (see p. 264) that in a considerable proportion of occipito-posterior positions there is *deficient flexion of the head* during labour. The reasons for this may be briefly recapitulated ; deficient flexion is due (*a*) to a tendency in posterior positions towards extension of the spine and therefore of the head : the convexity of the fœtal spine coming into relation with the convexity of the maternal lumbar vertebræ tends to extend the spine ; (*b*) to the obstacle offered by the pelvic walls to the descent of the occipital end of the head, while the sincipital end is free, the occipital pole lying in the narrowest part of the brim, viz., the space between the sacral promontory and the ilio-pectineal eminence. As labour progresses, one of two things occurs : either the head becomes well flexed, or it becomes partially extended. Flexion is more likely to occur if the uterus acts powerfully or if the pelvis and head are of normal size ; flexion is likely to fail if the uterine contractions are feeble, if the pelvis is abnormally small, or if the head is abnormally large. If the head becomes well flexed the occipital pole is the first part to reach the pelvic floor, with the result that the head makes a long rotation forwards and the occiput comes to lie under the pubic arch. This is the normal mechanism of labour in occipito-posterior positions ; it occurs in nine cases out of ten, and the labour terminates in the same way as an anterior position.

If, on the other hand, the head becomes partially extended so as to bring the occipito-frontal diameter into the pelvis, the sincipital pole will form its lowest part and the normal mechanism will be interfered with. In such a case either

(*a*) non-rotation of the head, the occipito-frontal diameter occupying approximately the transverse diameter of the pelvic cavity, or (*b*) backward rotation of the occiput into the hollow of the sacrum, will occur. This is the abnormal mechanism of occipito-posterior positions and does not occur in more than one-tenth of the cases.

Only those cases which end normally with anterior rotation of the occiput will be considered here; cases in which the head becomes extended belong to the section which deals with abnormal labour (p. 309).

Diagnosis.—The *diagnosis* of occipito-posterior positions has been already in part considered (p. 281), but the signs found on external examination may be briefly recapitulated. *First*, in thin subjects the abdomen may be observed to be flattened and slightly irregular, instead of convex and uniform, as in anterior positions. *Secondly*, on palpation the limbs are felt with unusual ease, and upon both sides of the middle line. *Thirdly*, the back may be difficult to locate. *Fourthly*, the wide, irregular frontal end of the head may be felt to be directed forwards. *Fifthly*, the position in which the heart-sounds are heard may also be of diagnostic importance (p. 283).

On internal examination during the second stage the finger may detect the anterior fontanelle lying within easy reach, and inclined to one or other side of the pelvis. The more deficient the flexion of the head, the lower is the anterior fontanelle and the more easily is it felt. Further, a careful observer may notice that the contour of the presenting part is abnormal, as will be understood by referring to Figs. 150 and 152. In anterior positions the presenting part is uniformly convex and nearly circular in outline; in posterior positions it is flatter and irregularly quadrilateral in outline. This results not only from the posterior position, but also from the accompanying deficiency of flexion. When spontaneous forward rotation occurs, the anterior fontanelle recedes out of reach, and an alteration in shape of the presenting part may become quite evident, as the head has at the same time become better flexed.

General Course of Labour.—Generally speaking, labour is prolonged and often attended with pains of unusual severity. Premature rupture of the membranes is more common. Both the first and second stages are prolonged. The descent of the head is unusually difficult for the reasons stated above, and in the second stage the pains often become very severe and almost continuous, although the labour makes but very slow progress.

The course of the second stage must be carefully watched, and special attention paid to the descent of the head, and to signs of rotation in one or other direction. More frequent examinations are necessary than in a normal labour, and the greatest care in observing the antiseptic routine is called for. Non-

rotation is usually accompanied by non-descent; when the head begins to make progress it usually also rotates, and in the great majority of instances the rotation is forwards, not backwards. Time is always required for rotation, and consequently a prolonged second stage is to be anticipated, and any attempt to unduly hurry the conclusion of this stage is to be deprecated. Rotation occurs when the head has been for some time on the pelvic floor, and in many cases does not take place until the perineum begins to bulge. Interference should be delayed until it becomes clear that spontaneous rotation will not occur, and the usual limits of this stage have been exceeded.

Management.—When a posterior position has been detected during the last weeks of pregnancy, or at the beginning of labour, an attempt may be made to correct it by external abdominal manipulations. This is done by locating the breech and the anterior shoulder, and endeavouring to rotate the body of the fœtus by pushing the anterior shoulder towards the *opposite side*. If the shoulder can be pushed across the middle line the position will be converted into an anterior. In a primipara this manœuvre is very difficult owing to the low level of the head; in a multipara it is easier, for the head lies higher. A method recommended by Buist, for correcting occipito-posterior positions during the last weeks of pregnancy, is to place a thick pad, such as a towel folded to the thickness of the forearm, along the extreme outer side of the abdomen towards which the back of the fœtus lies, and then to fasten on a tight abdominal binder; the fœtal back, being continuously pressed on, is often made to turn forwards. If corrected before labour the posterior position may recur.

The chief object of the management of labour in occipito-posterior positions is to convert the case into an occipito-anterior. Since nine out of every ten cases end naturally in forward rotation, little need be done until it becomes evident, during the second stage, that the occiput is not coming forward. The main cause of non-rotation forward is deficient flexion, and it is obvious that if the head could be fully flexed, forward rotation might occur spontaneously. The advice often given to promote flexion either by pushing up the sinciput with the fingers or by pulling down the occiput with an instrument such as a vectis during the pains, although theoretically sound, is difficult to carry out effectually. Further, it is almost always found that extension recurs, the reason being that it is associated with, and largely depends upon, extension of the spine; and the former probably cannot be corrected, except momentarily, apart from the latter. It is, however, useful to arrange that the patient should lie upon the side which will so affect uterine obliquity as to promote flexion, the left side in the third position, the right side in the fourth position. To push the uterus across

the middle line a thickly-folded towel may be placed at the side of the uterus and kept in position by a binder. When the second stage has lasted for three hours—or less, if the powers of labour have begun to fail—and there is no sign of forward rotation occurring, the case is abnormal and must be dealt with according to the directions given on p. 311.

Part IV

ABNORMAL LABOUR

In this section the following conditions will be considered :

(I.) *Abnormal Presentations.*
- Occipito-posterior positions with extension of the head.
- Face and brow presentations.
- Breech or pelvic presentations.
- Transverse or shoulder presentations.
- Twin labour.
- Prolapse of the cord and limbs.

(II.) *Abnormal Conditions of the Maternal Passages.*

(*a*) *The bony pelvis.*
- Pelvic contraction.
- Tumours of the pelvic bones.

(*b*) *The soft parts.*
- Ovarian tumours.
- Uterine tumours.
- Rigidity of the cervix.
- Rigidity of the pelvic floor.

(III.) *Abnormalities in the Action of the Uterus.*
- Precipitate labour.
- Uterine inertia.
- Tonic uterine contraction.
- Ante-partum rupture of the membranes.

(IV.) *Obstructed Labour.*

(V.) *Maternal Injuries in Parturition.*
- Rupture of the uterus.
- ,, ,, cervix and vagina.
- ,, ,, perineum and vulva.
- Hæmatoma.
- Inversion of the uterus.

(VI.) *Ante-partum Hæmorrhage.*

(VII.) *Retention of the Placenta.*

(VIII.) *Post-partum Hæmorrhage.*

(I.) ABNORMAL PRESENTATIONS

Occipito-posterior Positions with Extension of the Head

In about one out of ten occipito-posterior presentations the head fails to flex and the occiput to rotate forwards. The case

then becomes a *persistent occipito-posterior presentation.* The effects on the mechanism of labour of extension of the head have already been referred to on p. 264. One of two things occurs : either (1) the sincipital pole meets the pelvic floor first and rotates forward under the pelvic arch, the occiput turning into the sacral hollow, or (2) the head does not rotate at all, or rotates only partially, and becomes arrested in the pelvic cavity.

When the occiput turns into the sacral hollow the prognosis is not bad, for in the majority of cases spontaneous delivery

FIG. 187.—Illustrating the Difficulty in Delivery of Head in the persistent Occipito-Posterior Positions.

occurs after a long second stage. Spontaneous delivery is very much more likely to occur in a multipara than in a primipara. Fig. 187 shows that the shoulders enter the pelvic cavity along with the head, over-distending the vagina ; the descent of the presenting part is thus made more difficult (compare with Fig. 164). The part of the head which in this case first presents at the vulva is the region of the anterior fontanelle ; the occipito-frontal diameter ($4\frac{1}{2}$ inches) is therefore engaged in the antero-posterior diameter of the outlet. The vertex first passes out beneath the symphysis pubis ; then the perineum stretches and the occiput

slips over it ; finally the face passes under the symphysis, and thus the delivery of the head is completed by a movement of extension. It will be seen that much longer diameters of the fœtal head are engaged than when the occiput is anterior.

Fig. 188.—Rotating an Occipito-Posterior Position. Stage I. The whole hand has been introduced into the vagina and is grasping the anterior part of the head, the thumb on one side, the fingers on the other. The arrow indicates the direction in which the head is to be turned.

Further, the wide posterior part distends the perineum instead of emerging between the labia, and the risk of severe laceration is thus much increased.

When the head fails to rotate but is arrested in the transverse or oblique diameter of the pelvis, the case becomes one of " deep transverse arrest of the head " ; the head is usually arrested at

the level of the ischial spine plane (the narrow pelvic plane), the narrow transverse diameter of which is bridged by the occipito-frontal diameter of the head. The head in this position cannot descend further and cannot be born unaided.

Management of an Unrotated Occipito-posterior Position.—When the second stage has lasted for three hours—or less, if the powers of labour have begun to fail—and there is no indication

Fig. 189.—Rotating an Occipito-Posterior Position. Stage II. The head is now in the transverse diameter.

that forward rotation will occur, or that the head will be born spontaneously, the case must be terminated. From the point of view of management it is immaterial whether the head remains in the oblique or transverse diameter or whether the occiput has turned to the sacral hollow. The best treatment is to rotate the occiput forwards and then deliver immediately with forceps. One or two exceptions to this statement will be referred to later on. Rotation is performed by introducing the hand into the vagina, and

it is therefore called *manual rotation*. In almost all cases the head will be found to have passed the brim of the pelvis. It is much easier to rotate the flexed head than the extended head, and accordingly the first step is to flex the head as far as possible.

Complete surgical anæsthesia is requisite, and the manipulations can be carried out most easily with the patient in the modified lithotomy position, with the legs in Clover's crutch or supported by two assistants. The labia should be shaved and disinfected, and the operator should wear sterilised rubber gloves. The whole hand is passed into the vagina, and the position of the head first accurately determined. Then an attempt is made to flex it by pushing the forehead-end steadily upwards during a pain; the pressure may be continued during the interval if an assistant makes counter-pressure on the breech, which will steady the head and at the same time help to flex the spine. The head is flexed when the anterior fontanelle has been felt to pass further upwards. The anterior part of the flexed head is next grasped, as shown in Fig. 188, and then rotated so as to carry the forehead well to the lateral aspect of the pelvis (Fig. 189). But the head will not stay in its new position unless the trunk is rotated in the same direction. The operator or an assistant therefore attempts at the same time to rotate the trunk by pushing the anterior shoulder across the mid-line to the opposite side. This manœuvre will be comparatively easy if (1) there is plenty of liquor amnii remaining in the uterus; (2) the fœtus is not disproportionately large. The converse conditions will render it difficult or, it may be, impossible.

If the head is in the pelvic cavity the rotation may be carried further so as to bring the occiput into the mid-line anteriorly (Fig. 190); forceps are then at once applied, and the head can be easily delivered. If the head cannot be rotated further than the oblique diameter (Fig. 189), axis-traction forceps should be used, and the rotation will be completed during extraction (p. 636).

Complications.—(*a*) *The unrotated head is not engaged, i.e., it lies freely movable above the brim; the membranes are ruptured, and the cervix is dilated.* The non-engagement of the head is due partly to extension, and partly to uterine inertia, *i.e.*, feebleness of the contractions.

If the patient is a *multipara*, and has had previous easy labours, the safest method of delivery is version (p. 599). The alternative to version is to deliver by forceps, first rotating the occiput forwards; it is almost impossible to get the head through without first rotating it, as the forceps when applied to the unrotated head invariably slip during traction. Rotation is much more difficult than when the head is in the pelvis; as the hand is inside the uterine cavity it is not easy to grasp

the disengaged head firmly, and in order to rotate it may be necessary to pass the hand up to the shoulder of the child and rotate the trunk and head together. Even when rotation has been accomplished, unless there are active uterine con-

FIG. 190.—Rotating an Occipito-Posterior Position. Stage III. The occiput now lies to the front; the forehead is being pushed up to assist flexion.

tractions the delivery of the head by forceps will be extremely difficult.

If the patient is a *primipara*, version is unfavourable on account of the risk to the fœtus owing to delay in getting the head through the narrow vagina (see "Breech Presentations," p. 327). In such a case there is therefore no alternative to manual rotation and forceps.

If in the case under consideration the pelvis is contracted,

Cæsarean section should be performed when the fœtus is alive and apparently uninjured, craniotomy when it is dead.

(*b*) *The unrotated head is delayed in the pelvis, and the liquor amnii has drained away.* Although the head can be rotated, it is most difficult to rotate the trunk, and therefore the head turns back again when the pressure of the hand is removed. Axis-traction forceps should be applied, after rotating the head as much as possible. Steady traction during the pains may enable the head to descend and rotation to be completed, the instrument rotating as well as the head. When the head has

FIG. 191.—Usual Moulding in Occipito-Posterior Position. (Galabin and Blacker.)

thus been drawn down to the vulva, the blades should be removed and reapplied before delivering.

When the head does not rotate as it descends, if the patient is a primipara, extensive and serious lacerations, involving the rectum, will usually occur, as the head is delivered in an oblique diameter of the outlet, or 'face to pubes.' If the fœtus is alive, the risk must be run, and in a multipara the amount of laceration may be inconsiderable. If the fœtal heart-sounds have been inaudible for some time, craniotomy should be performed.

The *moulding* of the fœtal head in occipito-posterior positions differs somewhat from that in anterior positions (Fig. 191). The compression of the occipito-frontal plane is exaggerated, and the frontal bones are more markedly displaced beneath the parietal bones. The position of the caput has been already mentioned (p. 271).

Face and Brow Presentations

These presentations are brought about by complete extension of the head upon the spinal column, the occiput resting against the cervical vertebræ, and the chin being widely separated from the chest wall (Fig. 197). They occur in about 1 in 300 labours (0·3 per cent., Queen Charlotte's Hospital statistics). Little is known of the causes of this complete extension of the head,

Fig. 192.—Face Presentation : First Position.
(Ribemont-Dessaignes and Lepage.)

but it is believed that the following may be either essential or contributory causes :

1. Extreme obliquity of the uterus.
2. Pelvic contraction.
3. Large size of the fœtus.
4. Dolicho-cephalic fœtal skull (long antero-posterior diameters).
5. Congenital malformations—*e.g.* goitre and anencephaly.
6. Placenta prævia and hydramnios.

Face Presentation.—This presentation is very rarely met with in *pregnancy*, but appears to be usually produced during labour by conditions which prevent the easy entrance of the vertex into the pelvic brim. Causes 1, 2, and 3 therefore need no comment ; the influence of uterine obliquity in causing extension of the head has been already referred to. Considerable doubt exists whether the elongation of the antero-posterior diameters of the fœtal head, which is often met with

in face cases, is primary or secondary, many observers maintaining that it is produced during labour, and is therefore the effect, not the cause, of the presentation. The congenital malformations mentioned have been responsible for the very rare instances in which face presentation has been recognised before labour. Congenital goitre is not uncommon in countries where goitre is endemic, but elsewhere it is extremely rare; face presentation results from the mechanical obstacle to flexion. The anencephalic head lies naturally in full extension. Statistics show that face presentation occurs in primigravidæ and multiparæ respectively in the proportion of two to three, and repeated presentation of the face has been observed in successive labours in the same patient. Placenta prævia and hydramnios favour all kinds of abnormal presentation, but not especially that of the face.

The *attitude* of the fœtus is shown in Fig. 192. It will be noticed that, while the limbs are flexed, the trunk and spine are extended; the outline of the back is flat, not convex, and is broken below by the prominence formed by the occiput when the head is completely extended. The interval seen between the knees and elbows is of course caused by the extension of the spine. Four *positions* are distinguished as follows, the chin being the denominator of the presentation:

1st position	.	Right mento-posterior	R.M.P.
2nd „	.	Left mento-posterior	L.M.P.
3rd „	.	Left mento-anterior	L.M.A.
4th „	.	Right mento-anterior	R.M.A.

The third position is by far the commonest, which appears to indicate that face presentation usually results from complete extension occurring in an occipito-posterior position. The relation of the head to the pelvis at the beginning of labour is shown in Figs. 193 to 196. By comparison with Figs. 150 to 153 it will be seen that the presenting part occupies a comparatively small part of the pelvic space. In comparing the positions of the face with those of the vertex, it will be observed that they precisely correspond in respect of the position of the back of the fœtus; in the first and second positions it is anterior, in the third and fourth posterior, in both presentations. Thus, if in a first vertex position the head became completely extended, a first position of the face would result from it.

Diagnosis.—*Abdominal palpation* should be carried out in the systematic manner described in connection with normal labour. The actual shape of the fœtal ovoid will attract attention if the back is anterior (Fig. 192); the head in this case will lie well above the pelvic brim at the beginning of labour, even in a primipara, and the prominent occiput, with the sulcus between

it and the back, can be palpated. It is not nearly so easy to make out the *entire surface* of the back as in a vertex presentation, for a considerable interval exists between the upper dorsal

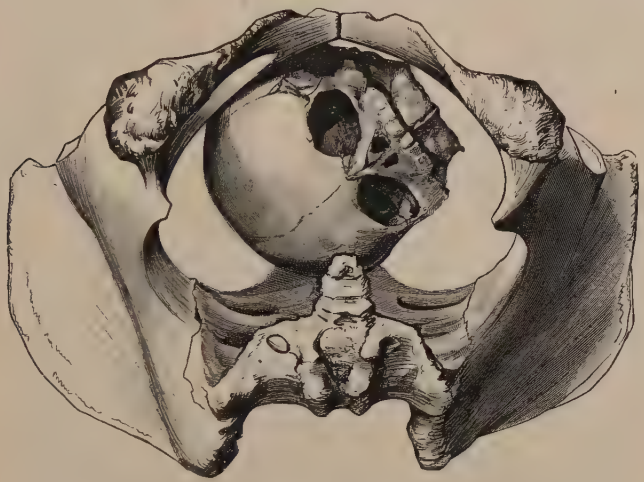


FIG. 193.—Face Presentation : Third Position.

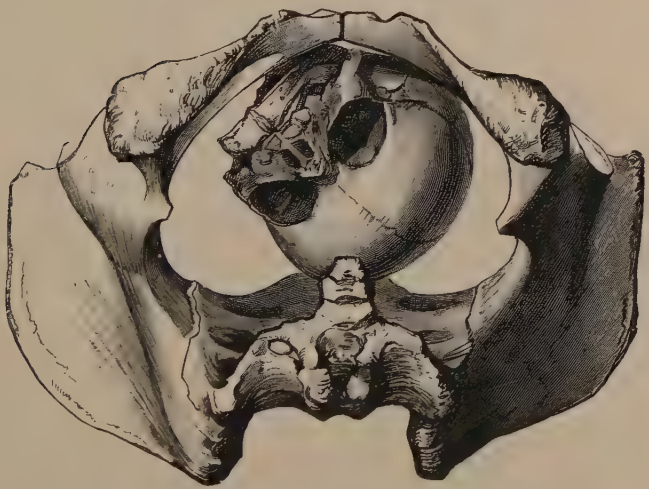
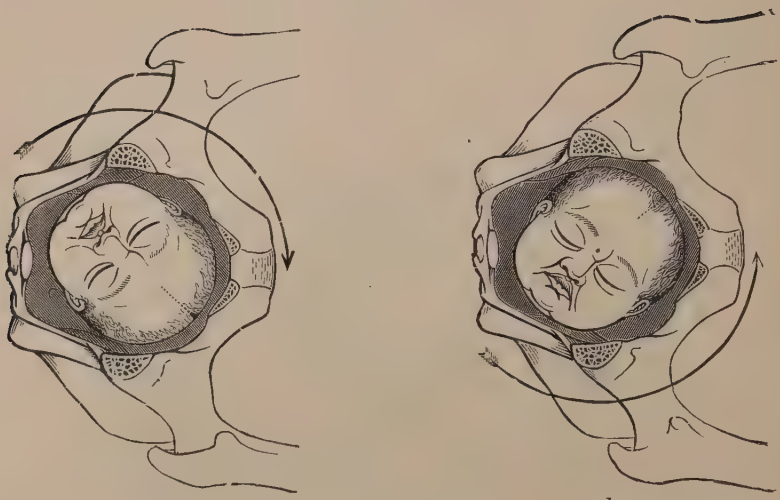


FIG. 194.—Face Presentation : Fourth Position.

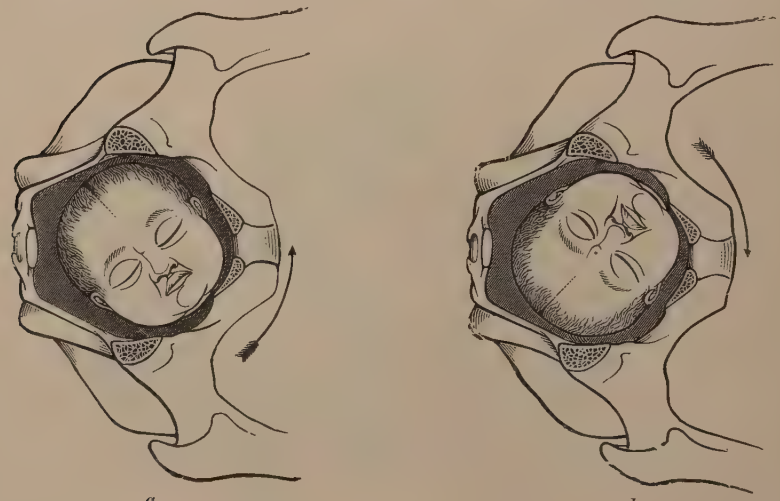
region of the back and the maternal abdominal wall. In palpating from the fundus downwards, the outline of the back is therefore lost before the occipital prominence is reached. When the back is posterior, the prominent occiput is not readily accessible to palpation ; but the small parts representing the



a *b*

FIG. 195.—Face Presentation. *a*. First Position. *b*. Second Position. (Farabœuf and Varnier.)

The arrow indicates the line of forward rotation. Patient in left lateral position.



a *b*

FIG. 196.—Face Presentation. *a*. Third Position. *b*. Fourth Position. (Farabœuf and Varnier.)

The arrow indicates the line of forward rotation. Patient in left lateral position.

limbs are extremely easily felt. The two most important points on palpation therefore are the indistinct outline of the back and the deep sulcus between the occiput and the cervical spine. *Auscultation* affords little help in diagnosis ; the heart is heard

at a somewhat higher level than, but otherwise in the same position as, in vertex presentations ; and in anterior positions of the chin the sounds are unusually distinct, as the chest is thrown forwards against the abdominal wall.

Vaginal examination at the beginning of labour is indecisive ;

Fig. 197.—Face Presentation : Third Position. The completely-extended face has descended into the pelvic cavity, and still lies in the right oblique diameter. The head is elongated antero-posteriorly.

the presenting part lies high and is ill defined in outline ; it will often be impossible to distinguish it from the breech. When the first stage is more advanced, the bag of waters will be noticed to be unusually large, and premature rupture of the membranes is fairly common. The large size of the bag is due

to the fact that, as the face does not fill the lower segment so well as does the vertex, a larger amount of liquor amnii descends below the presenting part. Great care should be taken not to rupture the membranes accidentally, but during the intervals between the pains it will probably be possible by gentle touch to recognise (*e.g.* in the third position) the frontal suture leading

FIG. 198.—Face Presentation. Forward rotation of the chin has occurred.

anteriorly to the orbital ridges and to the nose (Fig. 193). At a still later stage, when extension of the head has become complete and the cervix is further dilated, it will be found that the orbital ridges, mouth, and chin can all be reached and recognised by the finger. The direction of the chin will of course indicate which of the four *positions* of the face is present (see Figs. 195 and 196). During the second stage diagnosis by vaginal examination may become very difficult owing to the

tumefaction of the brow, cheeks, and lips (caput succedaneum), which results from pressure around the girdle of contact. The orbital ridges become obscured, and the mouth opens, but by passing the finger into the mouth the *alveolar processes* can always be recognised, and this is accordingly a most important diagnostic point. The nose undergoes little alteration, and conse-

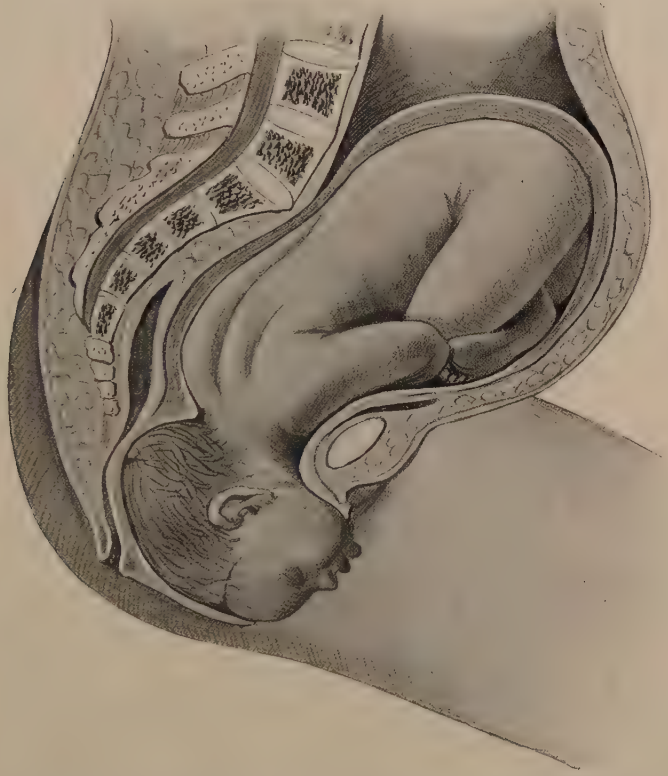


FIG. 199.—Face Presentation. The movement of internal rotation is complete, and the face is passing through the outlet by a movement of flexion.

quently the nares with the septum between them may still be recognisable (Fig. 202) when the other parts have become completely obscured by swelling.

Mechanism.—(1) Extension in a face presentation corresponds with flexion in a vertex. It is produced at the onset of labour by the conditions named above, and is progressive, being frequently incomplete until the head has descended well into the pelvic cavity (Fig. 197). When completely extended the

diameter of engagement is the sub-mento-bregmatic ($3\frac{3}{4}$ inches), which lies in one of the oblique diameters of the brim ($4\frac{3}{4}$ inches); when incompletely extended a longer diameter, the sub-mento-vertical ($4\frac{1}{2}$ inches), becomes engaged. The greatest transverse diameter of the face (bi-malar) is considerably less than that of the vertex, the bi-parietal. There is thus no difference between a fully-flexed vertex and a fully-extended face in the length of the diameter of engagement, while the transverse diameter is smaller; but it must be remembered that, whereas the size of the vertex may be reduced by moulding, the bones of the face are incompressible. Deficient extension influences a face presenta-

Fig. 200.—Moulding of the Head after Face Presentation. (After Budin.)

tion unfavourably by introducing a longer diameter of engagement.

(2) *Internal rotation* is probably controlled entirely by the slope of the pelvic floor; when the head is completely extended the chin is the lowest part, and therefore it first reaches the pelvic floor and is directed by the slope downwards and forwards under the pubic arch. If the position is the right mento-posterior, this will necessitate a long movement of rotation (about $\frac{3}{8}$ths of a circle) around the right wall of the pelvis. If the head is imperfectly extended so that the sinciput is lower than the chin, the latter will rotate backwards into the sacral hollow (*persistent mento-posterior position*). Natural delivery is then impossible, except in the case of a very small or macerated fœtus.

(3) *Flexion.*—After forward rotation of the chin has occurred

the head becomes disengaged by a movement of flexion, which thus takes the place of extension in a vertex presentation. The chin first emerges under the symphysis pubis ; then the face, forehead, vertex, and lastly the occiput pass successively over the perineum (Fig. 201). It is important that the chin should be brought well forwards under the pubic arch before flexion occurs, otherwise the mento-vertical diameter ($5\frac{1}{2}$ inches) must pass through the outlet instead of the sub-mento-vertical ($4\frac{1}{2}$ inches). It is therefore clear that the passage of the head through the vulva in a face presentation is always more difficult

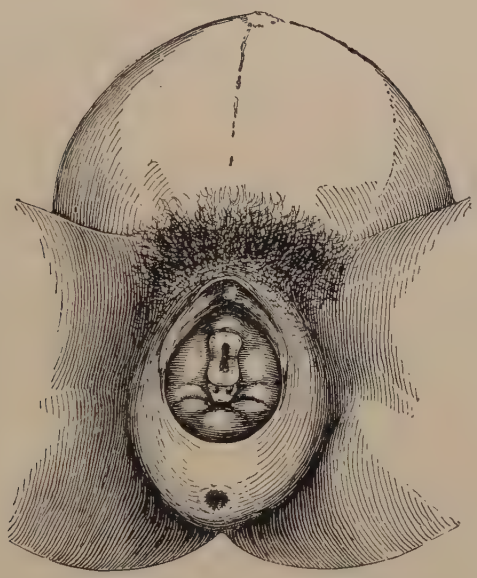


FIG. 201.—Delivery of the Head in Face Presentation : Movement of Flexion. (Ribemont-Dessaignes and Lepage.)

The swelling of the lips and the unaltered condition of the nares are shown.

than in a vertex presentation, owing to the greater length of the diameters of engagement.

(4) *Restitution* and *external rotation* are brought about by the same causes, and follow the same rule with regard to direction, as in vertex presentations.

The most favourable positions in presentation of the face are those in which the chin is anterior (third and fourth). In these the back is posterior, and the effect of its apposition with the maternal vertebral column is to extend the spine, and thus promote extension of the head—the normal mechanism of this presentation. In addition, the movement of forward rota-

tion of the chin is much shorter than in the first and second positions.

The effects of labour upon the head of the fœtus are very marked. The tumefaction of the face has been already referred to ; it is, of course, due to the formation of the caput succedaneum, but in this case the effusion is usually sanguinolent, giving the appearance of considerable bruising, often accompanied with small bullæ containing blood-stained fluid. The effusion, as a rule, becomes absorbed in a few days after birth, and the skin rapidly regains its normal colour. The changes produced during labour in the shape of the skull are also shown in Fig. 200. The vertex becomes flattened by being compressed against the pelvic wall, thus reducing the sub-occipito-bregmatic and sub-mento-bregmatic diameters, while the occipito-frontal diameter becomes greatly lengthened, the plane of principal compression being the plane of the sub-mento-bregmatic diameter.

General Course of Labour.—The mechanism of labour in a face presentation may be said to differ from that in a vertex mainly in the greater difficulty of the expulsion of the head and the more serious results of backward rotation. A face presentation, as a rule, brings no more risk to the mother than a vertex ; labour is, however, longer, because the face is a less efficient dilator, and the membranes are more liable to rupture early ; internal rotation occurs late in the second stage, and often not until the perineum is well distended by the advancing face ; further, as repeated examinations may be necessary for diagnosis, the strictest antiseptic precautions are called for. Spontaneous delivery occurs in 90 per cent. of cases if left alone. There is some increase of risk to the fœtus, owing mainly to the prolongation of labour and to the comparative frequency of such complications as premature rupture of the membranes and prolapse of the cord or of one of the hands. The fœtal mortality is about 10 per cent.

Management of Face Presentations.—The possibility of the pelvis being contracted should always be borne in mind in face presentations. Since the majority terminate naturally by forward rotation of the chin and spontaneous disengagement of the head, interference is not always called for. It is therefore the wisest plan to leave face presentations alone, and interfere only under certain well-defined conditions. The membranes should be very carefully preserved, for the face is an inefficient dilator ; therefore vaginal examinations should be made with special care, and the patient kept lying down during the greater part of the first stage. During the second stage what is possible should be done to promote extension ; forward rotation of the chin will then inevitably follow. Use may be made of uterine obliquity in promoting extension by directing

the patient to lie upon the side opposite to that on which the chin has been located; but upward pressure with the fingers on the forehead or downward traction on the chin, if attempted, must be applied very carefully, as the face may be seriously injured or the eyes infected. If the chin rotates backwards, or if forward rotation is much delayed, the best treatment is to anæsthetise the patient, and then rotate the head and trunk so as to bring the chin forwards, in the manner already described in connection with posterior positions of the vertex (p. 311). The chin should then be pulled down until the face is completely extended, and the head immediately delivered with forceps. If forward rotation cannot be accomplished in this way, it may prove possible to deliver with axis-traction forceps in the case of a small fœtus, even in the persistent mento-posterior position. If, however, this should fail, craniotomy will be required if the fœtus is dead; otherwise, Cæsarean section.

Fig. 202.—Face Presentation: the Head of the Child after Delivery. (Ribemont-Dessaignes and Lepage.)

If the presentation is complicated by prolapse of the cord or of a hand, the best treatment is to perform version by either the combined or the internal method (p. 604); the object of this interference is to avoid the increased fœtal risks of these complications.

It has been sometimes advised when a face presentation is recognised early in labour, before rupture of the membranes, that an attempt should be made to convert it into a vertex by flexing the head. It may be said that this procedure is unnecessary, difficult to carry out, and if not completely successful it does harm by bringing about the most unfavourable of all cephalic presentations—viz., the *brow*. The essential difficulty is that both the spine and the head must be flexed, or the face presentation will immediately recur. Methods of attempting this correction have been described by Baudelocque, Schatz, Thorn, and others, but it may be said that they are only suitable for the practice of lying-in hospitals, and cannot be recommended for general adoption. As a routine principle face presentations should be left to nature unless the conditions exist which, as has been mentioned, call for the performance of version. When face presentation occurs with a contracted

pelvis, the management of the labour will be governed mainly by the shape and size of the pelvis.

Brow Presentations.—When the head lies midway between the attitudes of complete flexion and complete extension, the brow presents at the brim, and the longest diameter of the head (mento-vertical, $5\frac{1}{2}$ inches) becomes the diameter of engagement. The shape and size of the mento-vertical plane, as shown in Fig. 203, makes the passage of the normal-sized head through the pelvis, when presenting in this way, well-nigh impossible. Probably this presentation should be regarded as a subvariety of the face presentation, due to arrest midway of the process of extension.

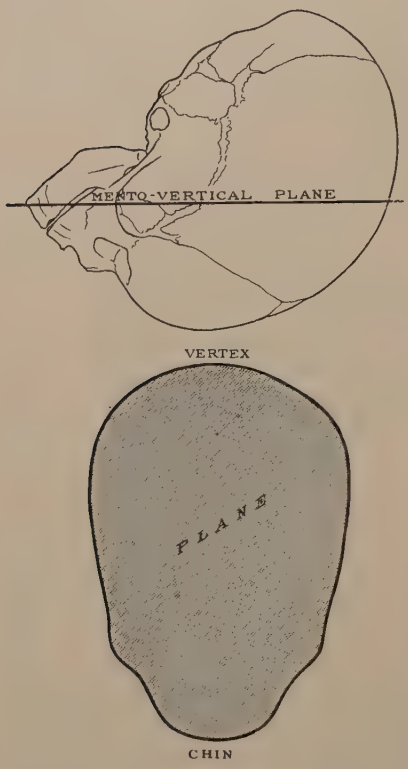


Fig. 203.—The Position and Shape of the Mento-Vertical Plane. (Edgar.)

Diagnosis.—Presentation of the brow usually passes unrecognised until labour is well advanced. The external examination may show nothing abnormal, while vaginally the presentation will be mistaken for a vertex until the cervix is well dilated. The brow presentation may then be recognised by the presence of the anterior fontanelle at one end of the presenting part and the orbital ridges at the other. When the mouth and chin can be felt, the presentation is a face. It is fortunate that persistent brow presentations are extremely rare (1 in 1,500 to 2,000 labours), for natural delivery is impossible unless the fœtus is undersized.

Mechanism.—The orbital ridges may be either anterior or posterior in brow presentations, the former being the more favourable. An anterior brow may be delivered naturally if the head is small, the pelvis is of normal size, and the uterus is acting powerfully. Moulding then occurs, which results in marked compression of the mento-vertical diameter, and compensating elongation of the occipito-frontal; this causes great bulging of the frontal bones. The head then descends with the

superior maxilla compressed against the pubes, the occiput lying in the sacral hollow ; the frontal region first appears at the vulva, and is followed by the vertex and occiput, the face and chin being disengaged from the pubes the last of all. This method accordingly resembles the delivery of the vertex in face to pubes cases as shown in Fig. 187, but in the case of the brow presentation the head is, of course, more extended. Very considerable deformity of the head, consisting of flattening of the vertex and bulging of the forehead, results. In posterior positions of the brow, forward rotation may occur, when the case ends in the manner just described ; if rotation does not occur natural delivery is impossible.

Management.—The great majority of brow presentations are *transient.* It is probable that every face presentation passes through the preliminary stage of a brow presentation ; cases may accordingly be observed to undergo spontaneous transformation to a face. A *persistent* brow presentation, however, is very dangerous, both to mother and fœtus ; therefore if detected early in labour, either before or soon after rupture of the membranes, version should be performed, and the presentation converted into a breech. If the case is complicated by any degree of pelvic contraction, Cæsarean section should be performed. If labour is too advanced for version to be performed, an attempt may be made either to flex the head, producing a vertex presentation, or to extend it completely, producing a face ; the latter is easier to perform, but great care must be taken not to injure the face or eyes. Unless the chin is anterior, conversion to a face does not greatly help matters. If the head is *fixed* in the brim, Cæsarean section offers the only chance for the fœtus and is probably safest for the mother ; the only alternative is to attempt delivery with forceps as soon as the cervix is sufficiently dilated. Craniotomy is the best method of delivery when the fœtus is dead.

Breech or Pelvic Presentations

When the pelvic extremity of the fœtus lies at the brim, and the cephalic extremity at the fundus, the presentation is called a *breech.* If the normal attitude of flexion is unaltered the presenting part will consist of the buttocks with the external genital organs, and one or both feet, the latter lying somewhat above the former ; this is called the *complete breech* (Fig. 204). Some alteration of the normal attitude is, however, not uncommon. The most frequent is extension of the legs upon the thighs, bringing the feet up to the sides of the neck ; this is called the *incomplete breech with extension of the legs* (Fig. 205). Sometimes, however, the thighs are extended and the legs flexed, bringing the knees down into the brim ; or, finally, both

the legs and the thighs may be partially extended, bringing down the feet. The two latter are often termed *knee* and *footling presentations*, but they must of course be regarded, not as distinct from, but as varieties of, the incomplete breech presentation. Breech presentations may therefore be classified thus :

A. Complete breech presentation.
B. Incomplete breech presentation.
(1) With extended legs.
(2) With extended thighs.
(*a*) Knee (legs flexed).
(*b*) Footling (legs extended).

Occurrence.—Breech presentations occur approximately in 1 in 30 (3·3 per cent.) of all labours ; if, however, premature

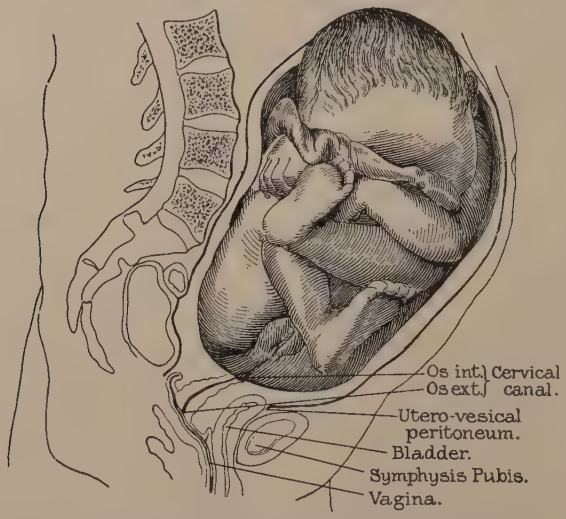


FIG. 204.—Complete Breech Presentation before Labour. From a Frozen Section. (Waldeyer.)

labours are excluded, the proportion falls to 1 in 60, showing that this presentation is much more frequent in premature than in full-time labours. It is usually stated that breech presentations occur somewhat more frequently in multigravidæ than in primigravidæ, but recent statistics from the Clinique Baudelocque (Paris) show that, excluding cases of contracted pelvis and of premature labour, the preponderance lies decidedly with primigravidæ. The incomplete breech presentation, in one or other of its forms, is commoner than the complete ; in primigravidæ, extension of the legs is the rule.

Causes.—It is customary to ascribe breech presentation to disturbance of the conditions which produce vertex presentation (see p. 253). Thus the cephalic end of the fœtal ovoid may be larger than the pelvic end, as in *hydrocephalus ;* the lower uterine segment may be unduly distended, and approximately equal in size to the fundus, as in *hydramnios ;* the centre of

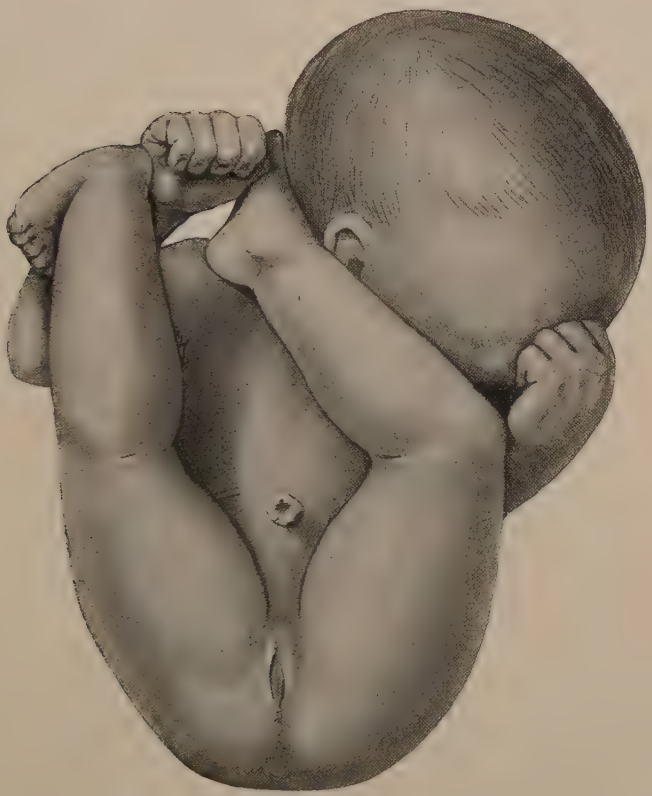


Fig. 205.—Breech Presentation with Extended Legs. From a Frozen Section. (Barbour.)

gravity of the *premature fœtus* lies near the centre of the body, and therefore the tendency to lie head downward in the liquor amnii is lost in premature labours. The chief reason for the relative frequency of breach presentation in premature labours is the freedom with which the premature fœtus can move about and change its presentation during pregnancy ; this is because the liquor amnii is relatively abundant and the presenting part is not engaged. It is only after about the thirty-sixth week of

pregnancy that the presentation becomes stable and the fœtus tends to settle down permanently as a vertex presentation ; before the thirty-sixth week changes in presentation from vertex to breech, or from breech to vertex, are frequently observed. In addition, *placenta prævia* favours the occurrence of breech presentation, for the presence of the placenta in the lower uterine segment diminishes the capacity of this part of the uterus, and so tends to displace the head when presenting. *Pelvic contraction* produces much the same result. It must, however, be admitted that many breech presentations occur

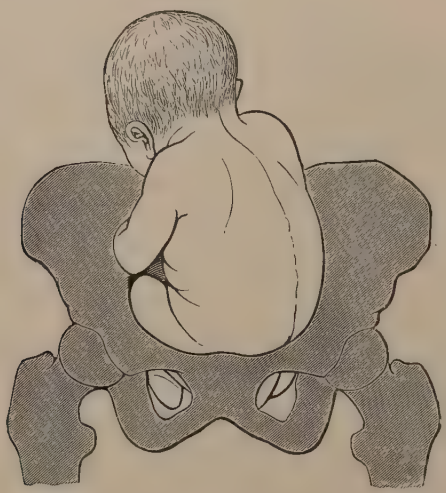


Fig. 206.—Breech Presentation : First Position. (Farabœuf and Varnier.)

in which none of these conditions is present, and they must therefore be regarded as merely contributory causes.

Four positions of the breech presentation are described, the sacrum being the denominator :

1st position .	.	Left sacro-anterior .	. L.S.A. (Fig. 206).
2nd ,, .	.	Right sacro-anterior	. R.S.A.
3rd ,, .	.	Right sacro-posterior	. R.S.P.
4th ,, .	.	Left sacro-posterior	. L.S.P.

Diagnosis.—Abdominal palpation should be carried out in the systematic manner already described. It is much easier to recognise a breech presentation by abdominal than by vaginal examination during pregnancy and in the earlier stages of labour. Suprapubic palpation will show that the fœtal pole which occupies the lower part of the uterus does not possess the characteristics of the head ; it is softer, more irregular, and less

defined in outline ; it usually lies above the level of the brim, and small parts moving spontaneously may be felt near it. The fundus must next be palpated with great care, when the head will be recognised by the points mentioned on p. 279. It will usually be found, not in the middle line, but at one or other side of the fundus (Fig. 204). It is easier to palpate its general outline than when the head lies at the brim ; owing to the greater capacity of the uterine cavity at the fundus, the head is freely movable upon its articulations.

Back and limbs will be found in the same way as with vertex presentations. In the incomplete breech presentation with

Fig. 207.—Shape of the Bag of Waters in a Premature Breech Labour. (Modified from Ribemont-Dessaignes and Lepage.)

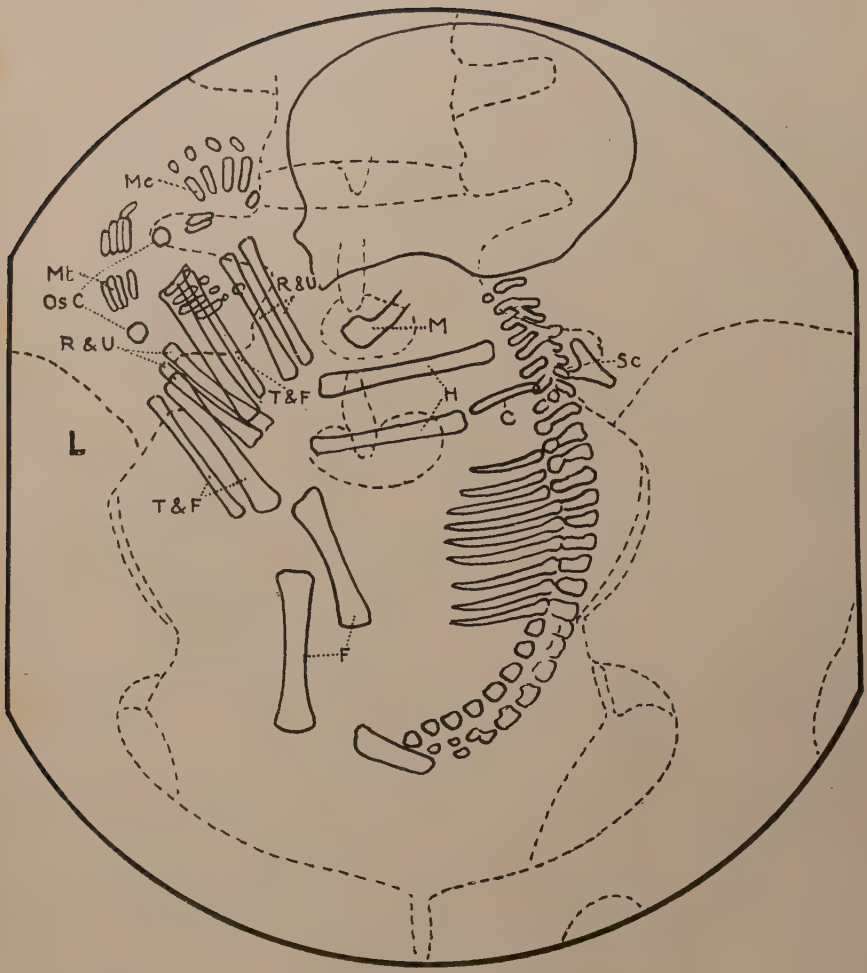
extended legs the feet lie close to the head and may be felt there *per abdomen* (Fig. 205) ; care will then be necessary to avoid the error of concluding that the breech lies at the fundus because small parts are found near it. The *heart-sounds* will be heard at about the level of, or a little above, the umbilicus—*i.e.*, somewhat higher than in vertex presentations, but in much the same relative position as regards the middle line (Fig. 283). In the first breech position the heart-sounds are unusually loud, owing to the fact that the back of the left shoulder is in close contact with the abdominal wall, a little to the left of the umbilicus (Fig. 206).

Vaginal examination early in labour will show that the pre-

senting part lies high and cannot easily be defined ; the cervix dilates slowly, and the bag of waters becomes unusually elongated, assuming a sausage shape, which is fairly characteristic of this presentation (Fig. 207). This alteration in the shape of the bag of waters results from the small size of the presenting part allowing an unusually large amount of liquor amnii to descend below it, thus elongating the membranes. Sometimes the presence of a small part (foot) can be detected in the bag of waters. Details of the presenting part cannot definitely be made out until the cervix is one-half dilated or the membranes have ruptured ; but at this stage the examining finger will first come into contact with the anterior buttock—smooth, soft, and round in outline, and much smaller than the head. Exploring further, the anus will be found, and beyond it again the coccyx and lower sacral vertebræ, the latter being recognisable by their row of small spinous processes. On the side of the pelvis opposite to that occupied by the sacrum one or both feet may be found (Fig. 208), and the finger may be passed into the cleft of the groin between the flexed thigh and the abdominal wall. The male external genital organs may also be recognised and the sex thus determined. The presence of meconium on the examining finger which has been passed into the anus is of course characteristic of this presentation. The localisation of the sacrum is of considerable importance, for by it the *position* can be recognised. In the first and fourth positions it lies to the left, and either in front or behind respectively ; in the second and third positions it lies to the right, and either in front or behind respectively. The diagnosis of position in breech presentations is not so important as in presentations of the vertex or face.

Fig. 208.—Breech Presentation : First Position.
(Ribemont-Dessaignes and Lepage.)
Patient in left lateral position.

The incomplete breech with extended legs is not easily recognised as such either by vaginal or abdominal examination when the presenting part is still in the pelvic brim ; when the breech has passed into the pelvic cavity, the fact that the feet are not



GUIDE TO PLATE VI.

The letters indicate the fœtal bones :

C.	Clavicle.	*Mt.*	Metatarsus.
F.	Femora.	*Os C.*	Os calcis.
H.	Humerus.	*R. & U.*	Radius and ulnar.
M.	Mandible.	*Sc.*	Scapula.
Mc.	Metacarpus.	*T. & F.*	Tibia and fibula.

PLATE VI

Radiograph showing Breech Presentation. The legs are extended, the femora lie over the maternal sacrum, and the hands and feet are in front of the face of the fœtus. (Radiograph by Dr. M. H. Jupe, The London Hospital.)

[*To face p.* 333.

within reach of the fingers may indicate this variety. The incomplete breech with extended thighs (knee or footling) is easily recognised on account of the small size of the presenting parts ; the foot may be mistaken for the hand before rupture of the membranes, but afterwards the foot can always be distinguished by the heel, the firm round knob being quite unlike any part of the hand.

Differential Diagnosis.—During pregnancy it is sometimes difficult to distinguish the breech from the vertex, especially in primigravidæ, when the liquor amnii is scanty and the breech is deep in the pelvis, with the legs of the fœtus extended ; in such a case the feet mask the head in the fundus, and the breech, enclosed in the stretched lower segment, feels very like the head in hardness and contour. In cases of doubt an anæsthetic will make the diagnosis easier and an X-ray plate will make it certain (see Plate VI.). During labour the face, especially if much swollen, may easily be confused with the breech, and so may the shoulder, especially when the presenting part lies high in the pelvis. The most serious error of all is to mistake a shoulder for the breech ; it can only occur if the routine of abdominal palpation is omitted.

Mechanism.—The diameter of engagement is in all cases the bi-trochanteric or bis-iliac (both 4 inches) which enters the brim in one or other oblique diameter ($4\frac{3}{4}$ inches). It will be observed that the positions correspond, as regards the direction of the back of the fœtus, with those of the vertex and face.

During the process of labour a movement of *internal rotation* occurs, affecting successively the breech, the shoulders, and the head. As the breech descends the bi-trochanteric diameter passes from the oblique of the brim (left in the first position) into the antero-posterior of the outlet, the anterior hip coming round under the symphysis pubis. The breech is then born by a movement of descent with lateral flexion of the spine around the pubes (Fig. 209). The anterior hip is first disengaged ; the posterior distends the perineum and follows it. At this stage the shoulders (bis-acromial diameter, $4\frac{3}{4}$ inches) engage in the same oblique diameter of the brim (left in the first position) as the breech, and in passing through the cavity internal rotation occurs, bringing the anterior shoulder under the symphysis pubis ; the trunk is born with the arms folded across the chest. While the hips lie in the antero-posterior diameter of the outlet, and the shoulders lie at the same time in the oblique diameter of the brim, a slight amount of rotation of the dorsal spine must of course occur. The head should enter the brim fully flexed, while the shoulders are passing through the outlet ; the sub-occipito-bregmatic diameter will then correspond with the right oblique, and forward rotation of the occiput follows, the anterior shoulder turning to the right side of the mother (first position).

The head now lies with the nape of the neck behind the pubes, the forehead in the sacral hollow, and the face upon the pelvic floor ; it becomes disengaged by the chin, face, and forehead successively passing over the perineum, thus maintaining the flexed position to the end. Backward rotation of the occiput is almost unknown in breech labour except when the fœtus is very small, or as the result of extension of the head from some kind of interference or from want of pelvic space. In the posterior positions of the breech (third and fourth), the mechanism of labour differs little from that of the anterior positions (first and second). Owing to the apposition of the vertebral column

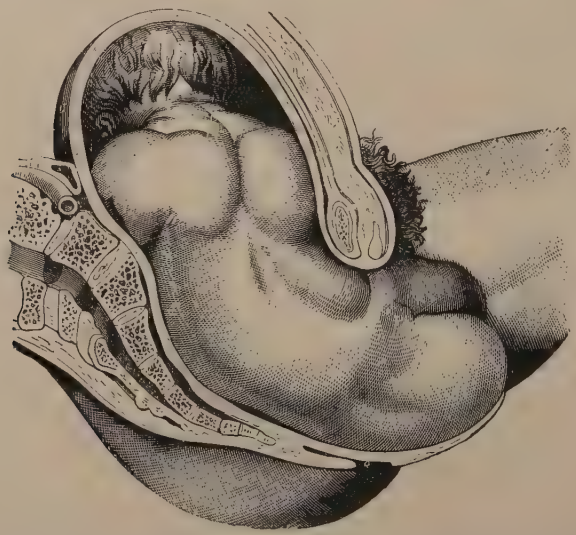


FIG. 209.—Birth of the Hips in Breech Presentation, showing Lateral Flexion of the Spine. The position is *second*, the shoulders engaging in the right oblique diameter.

of the fœtus to the maternal spine, the attitude of flexion is more difficult to maintain, and the occurrence of extension of the after-coming head is therefore more frequent. Internal rotation of the head is a long movement (three-eighths of a circle) as the head enters the brim with the occiput posterior ; if, however, flexion is complete, little difficulty is to be anticipated from the greater length of this movement.

Owing to their greater size, the delivery of the shoulders is more difficult than that of the breech ; the delivery of the head is more difficult than either, not because of the length of its diameters, but because it is less compressible than the breech or the shoulders, and because there is no time for moulding to occur.

The head is but little altered in shape by breech labour; no caput forms upon it, and there is almost no moulding. The general shape is therefore distinctly more globular than after a vertex presentation.

Anomalies in the Mechanism.—(1) Premature rupture of the membranes, with consequent loss of the dilating effect of the bag of waters, frequently occurs. (2) Extension of the legs may occur, either before labour as an abnormal attitude, or during labour from some obstacle to the descent of the complete breech. A breech labour is prolonged and difficult when extension of the legs occurs. This may be explained by the conditions present. Thus the extended legs act as splints to the trunk, tending to straighten it and to oppose the natural attitude of flexion. Further, the lateral flexion of the spine, which usually occurs during delivery of the trunk, is also prevented. Again, the later stages of labour will be impeded by the fact that the head and the feet enter the brim together. (3) One or both arms may become displaced (extended) (Figs. 212 and 220); the displaced limb then lies either at the side of, behind, or in front of the head, and forms an insuperable obstacle to spontaneous delivery. It also appears that extension of the legs produces upward displacement of the arms, apart altogether from the effects of traction in delivery. Fig. 205, from Barbour's 'Anatomy of Labour,' shows the attitude of the fœtus *in utero* with extended legs. It will be noticed that the right arm is abducted and the hand displaced upwards to the side of the head; the left hand is carried upwards in front of the face. In this attitude the upper limbs would of necessity become completely extended when they reached the level of the pelvic brim. It is also evident that extension of the spine has occurred in Fig. 205, so that the extension of the legs is only one of several departures from the normal fœtal attitude. (4) Non-rotation either of the shoulders or of the head may also occur, and delivery in the oblique diameter of the outlet will then be very difficult. (5) Finally, backward rotation of the occiput may occur spontaneously with a very small fœtus. Disengagement is then possible in one of two ways: if the head is completely flexed, the face, forehead, and vertex will pass successively under the symphysis; if extended, the chin becomes fixed against the pubes, the occiput is disengaged first, and is followed successively by the vertex and face, the chin coming last of all.

Prognosis.—Breech labour, in primiparous women, is accompanied by a combined fœtal and neonatal mortality of about 10 per cent.; in multiparous women the figure is less, for, owing to the smaller resistance offered by the vagina and perineum, the fœtus is more easily expelled and, should the necessity arise, is more easily extracted. Except that severe

perineal tears are more frequent, the maternal prognosis is no worse than in vertex presentations.

Post-mortem observations on breech-born children who are delivered dead, or who die shortly after birth, reveal the striking fact that in more than three-quarters of the cases there is evidence of intra cranial injury in the form of lacerations of the tentorium cerebelli and cerebral hæmorrhage. These injuries are due to too rapid compression of the head during delivery and prove that in the great majority of cases the fœtus is injured because the after-coming head is delivered too rapidly. The tendency for the accoucheur to hurry the delivery of the after-coming head is due to the false notion that after the body is born the fœtus will become quickly asphyxiated from pressure on the cord. On the contrary, we know that the oxygen requirements of the fœtus are small and that a vigorous fœtus is none the worse for ten minutes of cord compression. The death-rate of breech-born fœtuses will only fall when it is generally realised that the after-coming head must be delivered gently and deliberately and that head compression is much more dangerous than cord compression.

After intra-cranial injury the next most important cause of fœtal death is asphyxia, which is the primary cause of about one-quarter of the fatalities, and may be due to prolapse of the cord, to long delay in delivery of the head, or to prolonged pressure on the fœtus after the liquor amnii has drained away. Other fatal injuries are dislocation of the cervical spine and ruptured liver. Both are rare. The former can be caused by powerful traction during attempts to deliver the head ; and the latter is due to grasping the fœtus by the abdomen. Minor casualties are common, and include fractures and separations of epiphyses of the humerus, femur and clavicle ; they are liable to be caused during the liberation of extended arms and legs.

Prevention.—When a breech presentation is discovered during the last four weeks of pregnancy, or very early in labour, it should be converted into a vertex by *external version* (p. 601) in the interests of the child. It must be recollected that after correction the unfavourable presentation is apt to recur, and repeated examination should accordingly be made. Wearing a tight binder is of some assistance in maintaining the corrected position.

Management of Normal Breech Labour.—In the absence of abnormalities of mechanism or of maternal or fœtal complications, which may indicate interference or the prompt termination of labour, the rule is to leave things strictly to nature, and to intervene only to assist the delivery of the head. Untimely interference, such as extraction of the breech before the cervix is fully dilated, will lead to great difficulty in extracting the head.

It is therefore of special importance to avoid interfering too soon. During the *first* stage the breech usually remains high in the pelvis until the cervix is well dilated. There is a special tendency to early rupture of the membranes, and as this is liable to be followed by prolapse of the cord precautions should be taken to keep the membranes intact as long as possible; therefore, keep the patient lying down on her side during the whole of this stage, tell her not to strain, and do not make vaginal examinations. When the membranes rupture examine for the cord.

During the *second* stage the breech and body pass quickly through the pelvis, the perineum begins to bulge, and the anterior buttock soon distends the vulval orifice. As soon as the buttocks begin to appear the patient should be brought into the cross-bed lithotomy position with the legs held in a Clover's crutch or by an assistant, and the attendant sits down before the patient and awaits events. The dorsal position should be always used in a breech labour, and has great advantages over the left lateral position in facilitating the manipulations which may be necessitated by extension of the arms or delay in the birth of the head.

In the case of a primipara, or in any case where the fœtus is a big one, the advantages of perineotomy (Fig. 269) in facilitating the easy birth of the head are very great. Besides saving a possible severe perineal laceration, which is almost inevitable in a primiparous breech labour, the incision relieves the head of that quick compression which must always accompany its final exit, and which by causing intra-cranial injury and hæmorrhage is responsible for three-quarters of the fœtal mortality of breech labour. The incision should be made when the buttocks are distending the perineum, and, it is scarcely necessary to add, the patient should be under the influence of an anæsthetic. Another method of dilating the rigid vagina and perineum of a primipara is to use a de Ribes' bag during the second stage (see p. 594). It may be passed into the vagina as high up as possible, then inflated, and either left to be expelled by the natural forces, or by making traction on the bag it may be gradually drawn through the vulva so as to dilate it in advance of the breech.

After the buttocks and folded legs are born, the body quickly slips through to a distance well above the umbilicus. The exposed parts must be wrapped up in a warm towel and carefully protected during the remainder of the labour, in order to avoid the risk that cutaneous stimulation by cold air may prematurely excite the respiratory centre. In holding the fœtus at this stage the body and legs should be supported straddlewise on the left hand and forearm, and a loop of the cord should be drawn down so that its pulsations may be more easily felt and tension, if any, relieved. Traction on the legs is not required

at this period, and the temptation to pull must be steadily resisted, for it is obvious that traction will tend to produce extension of the spine, and this again will induce extension of the head, because the vertebral column articulates with the head nearer the occiput than the sinciput. But the descent of the trunk may be aided by pressure with the hand on the fundus during the pains ; fundal pressure is also useful in maintaining the flexed attitude of the arms and head. As the trunk descends it will be observed to rotate as the shoulders pass into the antero-posterior diameter of the outlet, the direction of rotation being from right to left in the first position. If the normal attitude of the arms has been preserved, the elbows will then appear closely pressed against the chest. Now only the head is left in the vagina, and the time has come for action on the part of the medical attendant.

The *birth of the head* is usually accompanied by a good deal of resistance from the vulval ring and perineum, especially in the case of a primiparous woman, and must be accomplished gently and deliberately. At the same time, it must be remembered that the fœtal circulation is at this stage interfered with by compression of the cord and that the fœtus cannot survive compression of the cord for more than ten minutes. When the fœtus is small the head may be spontaneously disengaged by a voluntary effort of the mother ; more often, however, assistance is required. The simplest method is to lift the body of the fœtus forwards towards the mother's abdomen and to make pressure on the head in the axis of the pelvic brim with the hand on the fundus. The fœtus is held so that it rides straddle-wise along the left forearm and hand, with the fingers forked over the front of the shoulders on each side of the neck. As soon as the head is so far born that the mouth is exposed the fœtus is able to perform the act of respiration, and may be held in this position for a considerable time without the least harm (as shown in Fig. 218). In cases of greater difficulty jaw and shoulder traction must be used (see p. 346 and Figs. 217 and 218). If the head cannot be delivered in this way, the forceps should at once be applied (see p. 642). The fœtal heart must be frequently auscultated during the second stage ; after the umbilicus is born the pulse can be felt in the fœtal end of the cord.

Management of Abnormal Breech Labour.—Difficulties may arise during a breech labour at three different stages : (1) the *breech is arrested* above the pelvic brim, in the pelvic cavity, or at the pelvic floor ; (2) the birth of the shoulders and arms is arrested by *extension of the arms ;* (3) the *head is arrested* above the brim or in the pelvic cavity.

(1) If the breech will not enter the brim or is arrested in the pelvic cavity after the second stage of labour has been in pro-

gress for a reasonable time it is because (*a*) the pelvis is contracted ; (*b*) the fœtus is very large ; (*c*) the uterine contractions are very weak ; (*d*) there is a tumour, such as a fibroid or an ovarian cyst, in the pelvic cavity, or there is the extremely rare condition of a large tumour growing from the sacral region of the fœtus.

The first thing to do is to anæsthetise the patient and make a thorough examination. Particular attention is paid to estimating the amount of disproportion, if any, between the fœtus and the pelvis ; when this is pronounced, Cæsarean section is the proper treatment, if expert operating and suitable conditions are available, if the fœtus is alive, and if there are no signs of maternal infection. If the patient is infected, Cæsarean section is a big risk, and the alternative is to deliver the fœtus by traction after bringing down a leg, and, if necessary, by evisceration and perforation of the after-coming head. Such extreme cases form only a minute proportion of those seen in practice ; usually the arrest of the breech is due to slight pelvic contraction, or to a large fœtus, or to uterine inertia, or to a combination of these. The treatment is to bring down a leg ; only if the cervix is fully dilated may the delivery of the fœtus be hastened by traction on the leg, otherwise the labour must be left for some time longer to the natural powers. After a leg has been brought down, the fœtal heart must be auscultated at short intervals, and the accoucheur must be ready to deliver the patient at short notice. When the arrest of the breech in the pelvic cavity is due solely to inefficiency of the uterine contractions, traction with a finger in the groin may succeed in delivering it.

Arrest of the breech at the pelvic floor is very common in primiparous labours ; the breech arrives on the perineum and may even begin to distend it, but no further progress is made. The delay is often due to the combined effect of a rigid perineum and uterine inertia, or to the fœtus being above the average in size.

But the most important cause of arrest of the breech at the pelvic floor is extension of the legs alongside the body of the fœtus. Extension of the legs tends to arrest further progress, partly because the wedge formed by the head, shoulders, and feet is too large to enter the pelvic brim and partly because the legs splint the body and interfere with lateral flexion. But extended legs by no means always cause arrest of the breech ; in a multipara, with no disproportion between the fœtus and the pelvis, the rapidity of labour is not in the least affected. In some primiparous labours also, beyond temporary delay of the breech on the perineum, the course of labour is unaltered ; but in such cases the fœtus is usually below the average size and uterine action is powerful. The diagnosis of extension of

the legs is made by passing the hand into the vagina and noting absence of the feet beside the breech.

The treatment of arrest of the breech at the pelvic floor depends on the cause. If due to rigidity of the perineum and vulval ring, or to uterine inertia, traction must be made on the groin of the fœtus during the pains ; if groin traction fails, a foot should be pulled down and traction made on the leg. The safest and surest mode of dealing with arrest due to extended legs is to bring down a leg. This is far preferable to groin-traction, because, if traction fails to deliver, the fœtus becomes firmly

FIG. 210.—Breech Presentation. Bringing down a Leg. (Ribemont-Dessaignes and Lepage.)

impacted in the pelvis (*impacted breech*) and the subsequent bringing down of a leg becomes more much difficult.

Bringing Down a Leg.—The patient is anæsthetised and is brought into the cross-bed position with the legs held in a Clover's crutch or by an assistant ; strict antiseptic precautions are observed and gloves are worn, and the bladder must be empty. The difficulty or ease with which a leg can be brought down depends on the firmness with which the breech is wedged in the pelvis, and on whether the legs are flexed or extended. Cases in which it is impossible to bring down a leg are extremely rare ; even when the breech seems firmly impacted and the uterus closely retracted round the fœtus, deep anæsthesia will

enable the breech to be pushed up and the hand passed beside the fœtus. When the legs are flexed the operation is easy enough, and almost as soon as the hand is introduced along the ventral aspect of the breech a foot is felt, is grasped by the fingers, and is gently drawn down in such a direction that the thigh is adducted across the body of the fœtus. The most convenient operating hand to use is the one which corresponds to the abdominal aspect of the fœtus.

When the legs are extended the hand is passed into the uterus along the ventral aspect of the fœtus and the fingers are laid along the thigh with the finger-tips on the popliteal region. The fingers then press the thigh against the trunk and outwards,with the result that the leg becomes flexed and the foot comes lower and can be more readily seized (Fig. 210). This manœuvre seldom succeeds if the uterus is closely retracted round the fœtus, and in that case the hand must be passed up to the fundus until a foot is reached; the foot is then drawn down so that the leg is flexed on the thigh. These manipulations must only be made during the intervals between the uterine contractions. The anterior is the better leg to bring down, for with the posterior leg down the anterior buttock is liable to catch on the symphysis pubis and arrest the progress of the fœtus. The point now to decide is whether traction should be made on the leg and the fœtus extracted. The decision will depend on the state of the cervix. If the cervix is not fully dilated the objections to traction are twofold; first, although the trunk may slip through easily enough there will be great difficulty with the arms, which are sure to become extended, and with the delivery of the head; secondly, deep lacerations of the cervix, perhaps extending into the lower uterine segment, may be caused. If, therefore, the cervix is not fully dilated, labour must be left to the natural powers until dilatation is likely to be complete, when the labour will very likely assume the conditions of a normal breech labour already described.

If there is fœtal distress or maternal exhaustion, or if it is unlikely that delivery will be effected by the natural powers, the fœtus is extracted. To minimise the risk of injury to the leg traction must be made from that part which becomes progressively nearest the vulval orifice. When both legs are out the fœtus should be held in the manner illustrated in Fig. 211; on no account should the abdomen be grasped, because of the danger of rupturing the liver.

Traction on the Groin of the Fœtus.—The forefinger having been slipped over the anterior groin, traction is made downwards and forwards; sometimes the posterior groin is easier to reach, and sometimes, if the breech is low enough, a forefinger can be slipped over each. The danger is that of fracturing the thigh; therefore, more than moderate force should never be

FIG. 211.

FIG. 212.

FIG. 214.

FIG. 213.

FIG. 211.—How to grasp the breech when traction has to be made on it. (Munro Kerr.)

FIG. 212.—Extended arms: how to grasp and rotate the fœtus (in direction of arrow) to bring the left arm posterior.

FIG. 213.—Extended arms: bringing down the posterior arm. (Munro Kerr.)

FIG. 214.—Extended arms: bringing down the anterior arm without rotating the fœtus. (Munro Kerr.)

FIG. 215.

FIG. 216.

FIG. 217.

FIG. 218.

FIG. 215.—Extended arms: how to rotate the fœtus (in direction of arrow) to bring the anterior arm posterior.
FIG. 216.—Dorsal displacement of arm: how to rotate the fœtus to disengage the arm.
FIG. 217.—Jaw and shoulder traction: first stage. (Munro Kerr.)
FIG. 218.—Jaw and shoulder traction: second stage.

used, and not more than one finger should be placed in each groin ; and the risk of fracture will be diminished if traction is made more on the trunkward than the thighward aspect of the groin. If moderate traction does not shift the breech a leg must be brought down. Traction on the groin is much more effective when made during a contraction, and the descent of the fœtus is greatly assisted by pressure on the fundus of the uterus, but during the contractions only.

Other Methods of Employing Traction on the Breech.—These are the blunt hook, the forceps, and the fillet. If ever used at all, they should only be used on a dead fœtus.

(2) Difficulty in the delivery of the arms results from their having become extended. Extension of the arms is seldom a primary displacement, but is usually the result of pulling too soon on the fœtus, or of contracted pelvis, or of insufficient dilatation of the cervix. In bringing down extended arms no time must be wasted, but the manipulations must be properly planned and gentle. A more serious displacement is 'dorsal displacement' of the arm (or arms), in which the arm lies at the back of the neck and crosses the pelvis below the head (Figs. 216 and 220) ; it is usually the result of premature and misdirected manipulations of the fœtus.

FIG. 219.—Delivery of the after-coming head with forceps. (Munro Kerr.)

How to Bring Down Extended Arms.—The body of the fœtus is usually so far delivered that the scapulæ are visible ; but sometimes the fœtus is arrested higher up, and these are the more difficult cases to deal with. The posterior arm must be delivered first :—(1) Hold the fœtus (as shown in Fig. 211) and draw it downwards until the lower angle of the scapula becomes visible or palpable. (2) Holding the fœtus, with the thorax grasped by the two hands, with the thumbs parallel to the spine (as shown in Fig. 212), rotate it by the shortest route until one shoulder is posterior. If the back is directed laterally, this step is obviously unnecessary, for one shoulder will already be posterior. (3) Holding the fœtus by the legs, lift it forwards and towards the side to which its abdominal aspect is directed (as shown in Fig. 213). This has the effect of depressing the posterior shoulder still lower. On no account must this be done unless the fœtus is so low that the scapulæ are out, or else the neck may be broken. (4) Slide two fingers

of the hand which corresponds to the arm of the fœtus to be brought down along the back over the posterior shoulder, along the upper arm, *until the bend of the elbow is reached* (Fig. 213); then press the arm downwards across the face until the arm comes down and out between the chest and the mother's perineum. On no account must the arm be pulled on nearer the shoulder than the bend of the elbow, or the humerus will certainly be fractured. (5) The anterior arm must now be delivered. To do this, hold the fœtus in a downward and slightly lateral direction, slide two fingers along the back, over the shoulder, and along the upper arm until the bend of the elbow is reached, and sweep out the arm in the manner already described (Fig. 214).

FIG. 220.—Dorsal Displacement of the Arm. (Galabin and Blacker.)

If the anterior arm cannot be brought down in the way described the trunk must be rotated to bring this arm directly posterior. To effect this hold the fœtus in the manner shown in Fig. 215, and rotate it in the direction that keeps the back of the fœtus looking forwards (in the direction of the arrow in Fig. 215) until the anterior shoulder comes to lie in the hollow of the sacrum, where the increased space will allow the arm to be brought down, according to the directions already given for bringing down the posterior arm. By rotating the fœtus in this direction the shortest route is taken and the head remains with the occiput anterior. There is a possibility that during this re-rotation of the fœtus the arm, meeting with friction against the birth-canal, may not follow the rotation of the fœtus, but may come to lie behind the head ('dorsal displacement' of the arm). The likelihood of such an occurrence is extremely remote. Should 'dorsal displacement' occur, the method of releasing the arm is shown in Fig. 216; a long rotation of the trunk must be made in the direction which brings the head away from the arm, until the displaced arm becomes posterior.

When the shoulders have come down as low as the pelvic outlet there should be no great difficulty in bringing down extended arms ; but if the arrest occurs higher up in the pelvic cavity there is great difficulty. Instead of two fingers, the whole hand will have to be introduced.

(3) Difficulty in delivering the *head* results either from its large size, from extension, or from backward rotation ; from contraction of the pelvis, from an imperfectly dilated cervix, or from a resistant vulval ring and perineum.

According to the particular cause, the head may be arrested (*a*) above the pelvic brim, (*b*) in the cavity, (*c*) on the pelvic floor. When the head is arrested above the brim or high in the pelvic cavity, the only available method of delivery is jaw and shoulder traction combined with fundal pressure from above ; when arrested low in the cavity or at the outlet, by a rigid vulval ring and perineum, if jaw and shoulder traction fails, the forceps must be applied. If backward rotation has occurred, an attempt should be made to rotate the head and trunk so as to bring the occiput forwards. Whenever the child is dead perforation should be performed without hesitation so as to secure easy delivery.

The mechanical disadvantage of extension of the after-coming head is indicated in Fig. 221. When flexed, the head forms a wedge the apex of which is directed downwards ; when extended, the base of the wedge is directed downwards, and descent is therefore much more difficult. In addition, the occipito-mental diameter ($4\frac{1}{2}$ inches) engages instead of the sub-occipito-frontal (4 inches).

Jaw and Shoulder Traction.—This is called the Mauricau-Veit method. The fœtus is held as shown in Fig. 217 ; the index-finger of the left hand is placed in the mouth to maintain flexion, and the first and second fingers of the right hand are forked well over the shoulders on each side of the neck with the finger-tips beyond the clavicles to exert traction. Having got a firm hold, the fœtus is first pulled downwards until the nape of the neck appears below the pubic arch (Fig. 217), upon which the direction of traction is then altered and the fœtus is swung upwards and forwards towards the mother's abdomen (Fig. 218). An assistant should at the same time make suprapubic pressure, but this must be well controlled, otherwise the head may be forced out too suddenly by the combined pressure and traction. The aim should be gradually to ease the head out by the intermittent exercise of force. It should also be recollected that when the head is born so far that the mouth is exposed, the fœtus is able to perform the act of respiration, so that there is no need from that point onwards unduly to hasten the delivery of the maximum (occipito-frontal) circumference of the head.

When arrested above or in the brim of a contracted pelvis the head passes best with the sagittal suture in the transverse diameter and moderately extended. The hand corresponding to the abdomen of the fœtus should be passed high up along the ventral aspect and two fingers placed in the mouth and the head guided into the transverse diameter of the inlet. The other hand is passed up along the dorsal aspect of the fœtus, and the fingers are placed forkwise over the shoulders. Whilst the hands pull and guide the head through the pelvis, an assistant makes firm pressure from above.

Delivery of the After-coming Head with the Forceps.—The

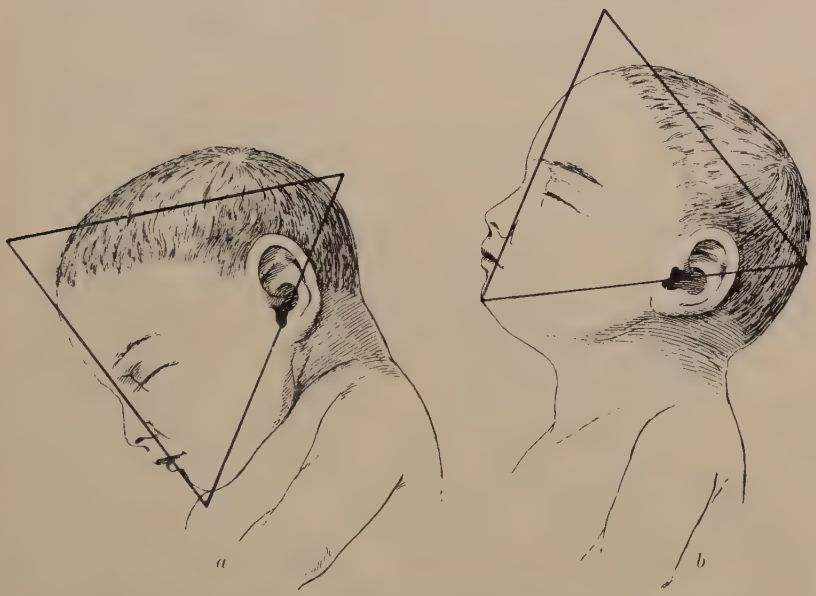


FIG. 221.—The After-coming Head. *a*. Flexed. *b*. Extended.

forceps should be boiled and ready for use at every breech-labour, though it will seldom be required ; it can only be applied if the head has come so low that the shoulders have passed the bony outlet and the pelvis is not blocked by the body of the fœtus. Injuries are less likely to occur than with jaw and shoulder traction, because the pull is taken direct from the head, and is not transmitted through the neck, and head-flexion is well maintained. The body of the fœtus must be held forward by an assistant. Its application is shown in Fig. 219.

Perforation of the After-coming Head.—The perforator is made to enter the cranial cavity through the occipital bone or through the roof of the mouth, whichever is the more easily

reached, the body of the fœtus having been pulled forwards or backwards to fix the head and to make more accessible the part to be perforated.

Transverse or Shoulder Presentations.

These presentations include all cases in which the long axis of the fœtus lies more or less directly across the long axis of the uterus—*i.e.*, all varieties of the transverse or oblique *lie*. Some part of the trunk of the fœtus presents, almost invariably by its lateral aspect. The shoulder (acromion process) in most instances forms the denominator of the presentation; but sometimes the arm becomes prolapsed and descends first into the vagina (Fig. 223), while at other times the lateral aspect of the abdomen, or even the back, forms the actual presenting part.

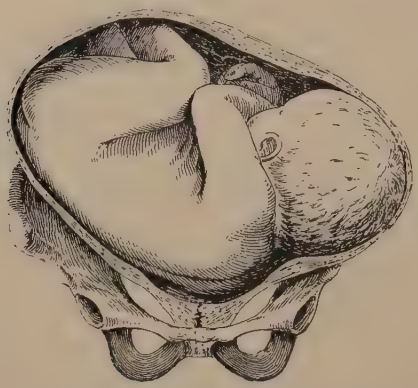


Fig. 222.—Shoulder Presentation: Dorso-Anterior Position. (Ribemont-Dessaignes and Lepage.)

The general attitude of flexion is preserved.

It is usual to describe only two positions of the shoulder presentation, *dorso-anterior* and *dorso-posterior;* the former is much commoner than the latter, because the fœtus accommodates itself better in that position to the forward curvature of the lower dorsal and lumbar vertebræ. In the former the normal fœtal attitude of flexion is fairly well preserved (Fig. 222); in the latter the spine becomes extended and displacement of the limbs is frequently met with (Fig. 223); premature rupture of the membranes and prolapse of the cord are common in both positions. The head usually occupies the iliac fossa, the breech lying upon the opposite side at a somewhat higher level, so that the long axis of the fœtus is, strictly speaking, not transverse but oblique. More rarely the breech occupies the iliac fossa, while the head lies at the higher level.

Occurrence.—Shoulder presentations occur in about 1 in 200 (0·5 per cent.) labours. When premature labours are excluded the rate of frequency is much reduced. They are five or six times more frequent in multigravidæ than in primigravidæ.

Causes.—All conditions which prevent the ready descent of the fœtal head into the pelvic brim may occasion a shoulder

presentation—*e.g.*, pelvic contraction, hydramnios, placenta prævia, twins, extreme uterine obliquity, laxity of the uterine and abdominal muscles, premature or dead fœtus, etc. It will be recollected that the same conditions may cause other forms of abnormal presentation. The relative frequency of this presentation in multiparæ is probably to be explained by permanent weakening of the abdominal muscles, permitting forward or extreme lateral displacement of the uterus to occur.

FIG. 223.—Shoulder Presentation: Dorso-Posterior Position. (Ribemont-Dessaignes and Lepage.)
The spine is extended and the limbs are displaced.

Diagnosis.—This presentation can easily be recognised by abdominal palpation, *before labour has begun*, or *early in the first stage* when the membranes are intact. The uterus is not pyramidal in shape, but irregular, the long axis lying more or less completely across the abdomen; as the presenting part cannot descend into the brim, the level of the fundus is unaltered. Systematic palpation will show that the head occupies one or other iliac fossa, and usually that the back is anterior; the breech will then be found on the opposite side and at a higher level than the head; occasionally, however, the breech will be found in the iliac fossa. Auscultation of the fœtal heart does not assist the diagnosis of this presentation.

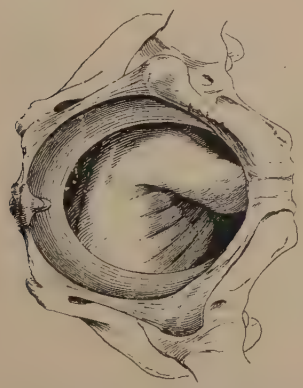


FIG. 224.—Shoulder Presentation: Dorso-Posterior Position. (Ribemont-Dessaignes and Lepage.)
Patient in left lateral position.

In examining women who are several weeks short of full time, transverse presentations are comparatively frequently met with; probably a certain proportion of them become corrected spontaneously before labour. The lie in such cases

is often quite irregular, the whole body of the fœtus lying well above the pelvic brim.

Nothing can be made out on vaginal examination before labour, except that the presenting part lies high up and is soft to the touch. During the first stage a large and elongated bag of waters will form, in which a small part—the arm—may be felt; if the membranes have ruptured, the arm may become prolapsed early in labour.

Late in labour when the liquor amnii has escaped and the uterus has become moulded around the body of the fœtus, detailed abdominal palpation is very difficult, and the position of the different parts of the fœtus cannot in this way be made out. Diagnosis must then be made by *vaginal examination*. A prolapsed arm will, of course, settle the presentation at once, and the position of the head and back can be deduced from the relation of the hand when supinated, the thumb pointing to the head, the palm corresponding to the ventral aspect. When prolapse of the arm does not occur, diagnosis will be more difficult. In almost all cases, however, the ribs with their intercostal spaces, or the vertebral spines, can be recognised with the finger, which usually reaches the former along the posterior axillary border (Fig. 224); these parts can hardly be mistaken for anything else. The angle of the scapula, freely movable and projecting from the surface of the back, may also be recognised, and is useful as indicating the position of the back. The acromion process and the curved clavicle may also sometimes be identified. By passing the exploring finger towards the right or left side of the mother the finger can be passed into the pit formed by the apex of the axilla; the head, of course, lies upon the same side of the pelvis as the axillary pit.

Fig. 225.—Attitude of the Fœtus in Spontaneous Evolution. From Nature. (Ribemont-Dessaignes and Lepage.)

Mechanism.—Natural delivery in a shoulder presentation is impossible when the fœtus is full-sized; under exceptional circumstances, however, it may take place in one of the following three ways:

A. *Spontaneous version* may occur—*i.e.* the presentation may spontaneously become transformed into a breech or a

vertex. This occurrence has been observed early in labour, before the membranes have ruptured or the presenting part has become engaged. It was first described by an English obstetrician of the eighteenth century named Denman. The term 'spontaneous version' is usually applied only to the transformation of a shoulder into a breech presentation; when transformed into a vertex the process is called *spontaneous rectification*. This is an unnecessary distinction, since version may be either cephalic or pelvic (see p. 599). No precise observations have been made upon the mechanism of spontaneous version; its occurrence is no doubt very rare.

B. *Spontaneous evolution* may occur when the fœtus is small or macerated, the pelvis large, and the uterine contractions powerful. This process, first described by a Dublin obstetrician, Douglas (beginning of nineteenth century), has been studied by Ribemont-Dessaignes and others who were able to obtain photographs of the different stages of delivery. The attitude assumed by the fœtus is shown in Fig. 225; extreme flexion of the head and the cervical spine occurs, causing severe compression of the thoracic and abdominal viscera; and even if the fœtus is alive at the onset of labour, death invariably occurs during delivery.

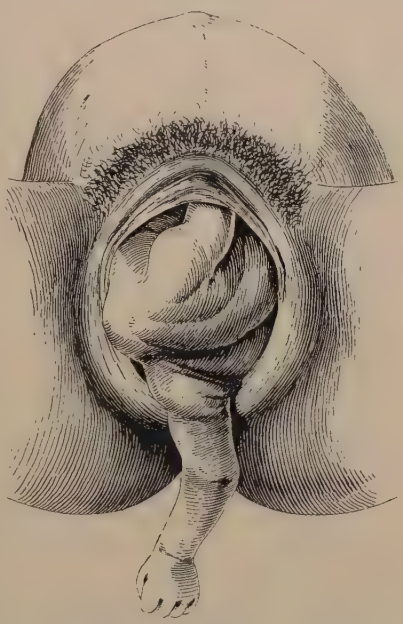


Fig. 226.—Spontaneous Evolution. Photographed from Nature. First Stage of Delivery, showing Prolapse of Posterior Arm. (Ribemont-Dessaignes and Lepage.)

Prolapse of the posterior arm first takes place, and the head and trunk then become compressed by the uterine contractions into the smallest possible bulk. After the expulsion of the prolapsed arm and shoulder (Fig. 226) the anterior shoulder appears under the symphysis, and the back follows, being expelled in the oblique diameter of the outlet. As the disengagement of the trunk proceeds a movement of rotation occurs, carrying it into the transverse diameter, the head being on one side, the breech on the other (Fig. 227). Forward rotation of the shoulders next takes place, bringing the neck

under the symphysis pubis, and the legs become disengaged in the antero-posterior diameter (Fig. 228). Labour terminates like a breech case with the delivery of the after-coming head. The fœtus represented in these figures (photographed from nature) weighed five and a half pounds.

In Fig. 229 is shown the process of evolution arrested at an early stage by the death of the mother. The attitude of the fœtus is similar to that shown in Fig. 225, and the greater part of the trunk has been driven into the vagina. This constitutes what is clinically known as an 'impacted shoulder.' The special risks which attend all methods of delivery in impaction of the shoulder are indicated by the condition of the uterus. It will be seen that the lower uterine segment is thinned, the bladder elevated, and the upper part of the uterus much retracted.

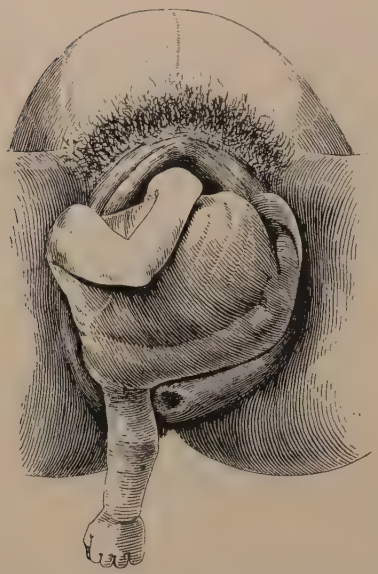


FIG. 227.—Spontaneous Evolution. Second Stage, showing Delivery of Back in the Transverse Diameter. (Ribemont-Dessaignes and Lepage.)

C. *Spontaneous expulsion* is also described as a possible termination in the case of a macerated fœtus. From the accounts of observers who have watched the process, it is clear that it does not differ in any important respect from spontaneous evolution, and scarcely deserves to be recognised as distinct from the latter. The trunk of the macerated fœtus is very compressible, and may therefore be more completely bent upon itself, allowing the head and breech to be disengaged together (Fig. 230).

It must be clearly understood that these natural terminations of shoulder presentations are exceptional occurrences, and cannot under any circumstances be awaited. This presentation must invariably be dealt with by immediate interference in the manner indicated below. If allowed to continue, the case will in all probability become one of *obstructed labour ;* over-distension of the lower uterine segment will ensue (see p. 423), the fœtus will die of compression, and the mother, unless rescued by operative measures, will die undelivered, either of exhaustion or of rupture of the uterus.

Management.—Since it is impossible, under ordinary conditions, for natural delivery to take place in shoulder presentations, the treatment consists in converting the presentation into a vertex or a breech by one of the methods of version, provided that labour has not advanced too far to permit of this being done. These methods will be described in connection with the obstetric operations. If abdominal examination is regularly practised during the latter weeks of pregnancy, shoulder presentations may be discovered before the onset of labour, and at this time they can be corrected by external version with ease and with perfect safety both to the mother and the fœtus. If the pelvis is of normal size, cephalic version should be practised. The mal-presentation is, however, apt to recur, as will be readily understood if its causes are borne in mind. After correction of a shoulder presentation in pregnancy the patient should accordingly be examined every few days until labour begins. When the diagnosis is made early in labour and the membranes are intact, the mal-presentation can also, as a rule, be corrected by external version. At this stage it is better to perform external podalic version, and then rupture the membranes and bring down a foot into the vagina, so as permanently to correct the mal-presentation. This can be carried out without difficulty if the cervix is large enough to admit two fingers under anæsthesia. If the pelvis is found to be contracted, Cæsarean section should be performed.

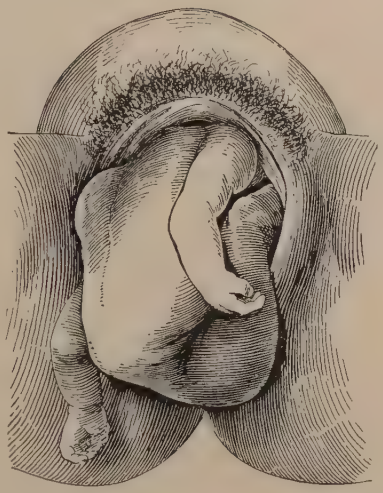


Fig. 228.—Spontaneous Evolution. Third Stage, showing Forward Rotation of Shoulders and Delivery of Legs. (Ribemont-Dessaignes and Lepage.)

If the membranes have already ruptured and an arm is prolapsed, external version is impossible. In such cases a loop of the cord also may become prolapsed, a complication which adds greatly to the fœtal risks. These complications may be dealt with as follows :

(1) If the cervix is one-fourth dilated (two fingers), the patient should be anæsthetised, the prolapsed parts carefully returned into the uterus, and a de Ribes's bag then introduced into the cervix. This will prevent recurrence of the prolapse,

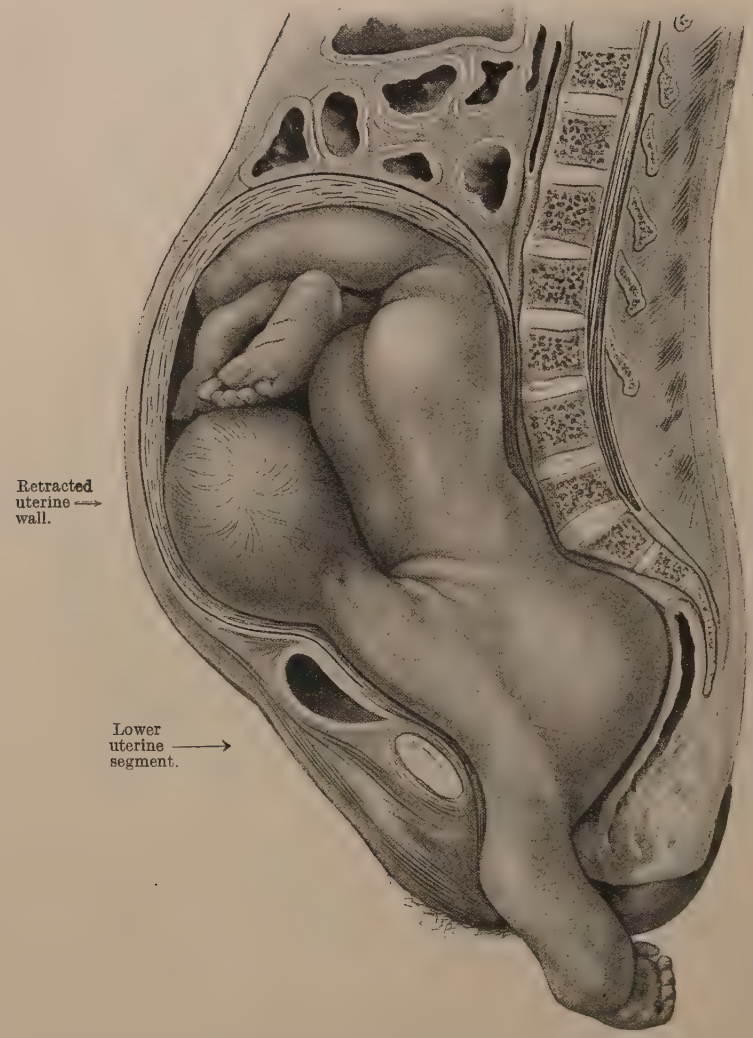


FIG. 229.—Impacted Shoulder Presentation illustrating a Stage of Spontaneous Evolution. Section from a woman who died in labour. The lower uterine segment is greatly thinned, and the bladder lies completely above the pubes. (Barbour.)

and at the same time dilate the cervix and prevent further escape of liquor amnii.

(2) When the cervix is one-half dilated, the hand may be passed into the uterus, and the fœtus turned by bringing down

a leg (internal version), the cord at the same time being returned into the uterus, where it will be safe from compression. Delivery may then be left to nature.

(3) Sometimes shoulder presentations are not seen until labour is advanced, the liquor amnii has all drained away, and the uterus is retracted over the body of the fœtus (Fig. 229). As will be seen in a later section, this condition, if allowed to continue, is attended by a very grave maternal risk, viz., rupture of the uterus. Version under these conditions is, generally speaking, impracticable, and any attempt to effect it, unless conducted with great care and skill, is liable to precipitate a rupture. Version therefore is not to be recommended (*a*) unless sufficient liquor amnii remains in the uterus to allow some degree of mobility to the fœtal parts; (*b*) unless the uterus becomes well relaxed between the pains, showing that there is no tonic contraction (see p. 411); (*c*) unless there are no signs of over-distension of the lower uterine segment, such as undue prominence, and unduly high level of the retraction ring (see p. 424). When the conditions are such as to negative version the fœtus is nearly always dead, and the method of delivery may accordingly be selected with reference solely to the interests of the mother. The usual method employed is decapitation, followed by separate delivery of the trunk and the head. In all cases, when the conditions present are unfavourable for version, and the fœtus is dead, decapitation should be preferred.

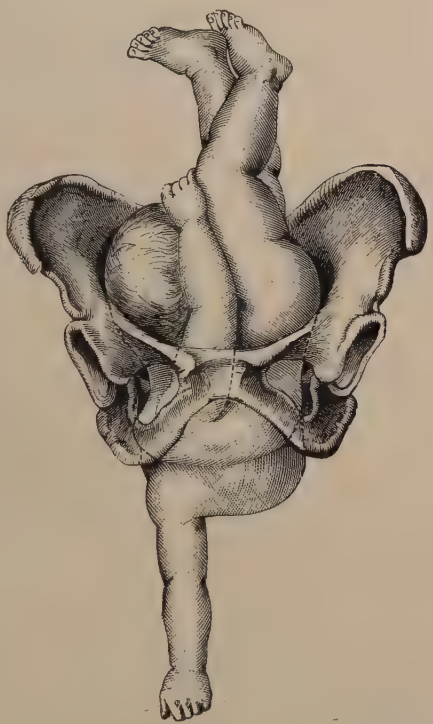


FIG. 230. — Transverse Presentation. Delivery by Spontaneous Expulsion. (Kleinwächter.)

In all cases of labour with transverse presentation, if the pelvis is found to be contracted and the fœtus is alive and viable, Cæsarean section should be considered.

Twin Labour

The diagnosis of twin pregnancy has been considered on p. 90.

Presentation.—The two fœtuses are almost invariably placed side by side in the uterus, the *lie* of each being longitudinal; more rarely one is placed entirely above the other. The com-

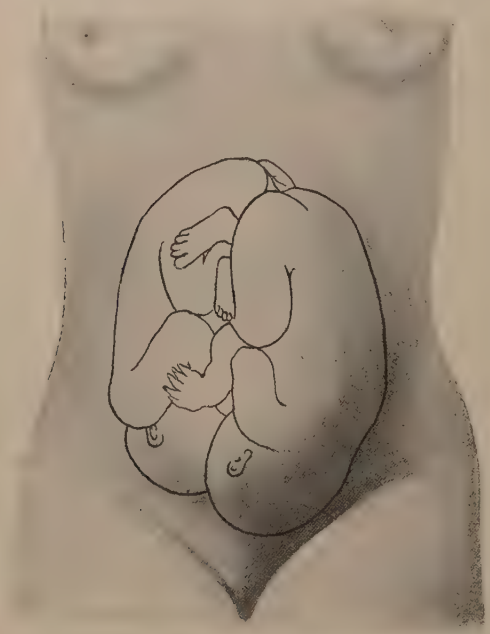


Fig. 231.—Twin Labour, both Fœtuses presenting by the Vertex.

monest presentations are the following, the proportions being those compiled by Leonhard:

First fœtus vertex, second fœtus vertex	. . .	38·5%
First ,, vertex, second ,, breech	. . .	21·1%
First ,, breech, second ,, vertex	. . .	14·3%
First ,, breech, second ,, breech	. . .	10·7%
First ,, vertex or breech, second fœtus shoulder	.	12·5%
		97·1%

The remainder are made up of various combinations, the rarest of all being that in which both presentations are transverse.

The *diagnosis* of twins is often easier at term or during labour than at earlier periods of pregnancy. If the fœtuses are placed as in Fig. 233 it will be comparatively easy to determine the presence of two heads, one at the brim and one at the fundus. If, however, the twins are placed one in front

of the other, the presence of the posterior (Fig. 232) may escape the most careful observation. What has been already said in another place must, however, here be repeated, viz., that a much more certain diagnostic point is the auscultation of two fœtal hearts by two observers listening simultaneously at different spots, with a definite difference in the rate of the two.

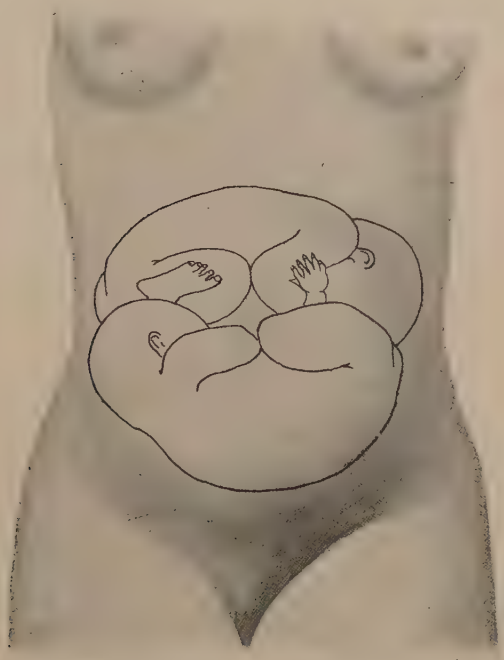


Fig. 232.—Adaptation of Twins *in utero* both lying transversely. (Galabin and Blacker.)

In cases of uncertainty, an X-ray plate will settle the diagnosis beyond doubt. The frequency with which hydramnios, and to a less extent toxæmic conditions, are associated with multiple pregnancy, should also be borne in mind. When the cervix is dilated two bags of membranes may sometimes be felt.

General Course of Labour.—With twins, labour frequently comes on prematurely, and shows an increased liability to the occurrence of certain complications, such as (*a*) hydramnios (usually affecting one sac only); (*b*) premature rupture of the membranes; (*c*) prolapse of a loop of the cord or a limb; (*d*) uterine inertia; (*e*) complex presentations. Twin labour is usually somewhat prolonged; this is due partly to weakness of the over-distended uterine wall, which results in primary

inertia (see p. 408), and partly to the fact that the stage of expulsion is duplicated. These disadvantages are to some extent counterbalanced by the small size of twin fœtuses. In other respects the course of labour depends entirely upon the relation of the fœtuses to each other. When the pelvis is full-sized or unusually large, the first fœtus, being small, does not fill it, and the presenting part of the second may enter the brim simultaneously with the first; the passage of both will thus become obstructed; this is known as *twin locking*. It must be

Fig. 233.—Twin Labour: First Fœtus presents by the Vertex, Second by the Breech (incomplete).

recollected that this complication is extremely uncommon, and, according to Von Braun, occurred only once in 90,000 deliveries in Vienna; as twin labour occurs in something like 1 in 80 to 90 cases, it follows that twin locking occurred, in Von Braun's series, in only 0·1 *per cent. of twin labours*. The following are the principal varieties: (1) two vertex presentations; one head lying in advance of the other, the vertex of the second enters the brim together with the neck of the first, and neither can make progress; (2) first breech, second vertex presentation;

the vertex of the second enters the brim in advance of the after-coming head of the first, and the two heads become locked either *chin to chin, side by side, occiput to chin,* or *occiput to occiput;* (3) the first presents by the vertex or breech, the second transversely. In varieties (1) and (2) natural delivery is possible if the pelvis is large, the uterine contractions are powerful, and the fœtuses are small; when these conditions are not present, and invariably in the third variety, insuperable obstruction to natural delivery will result.

Management of Twin Labour.—Since the first fœtus almost invariably presents by the head or breech, its delivery may be left to the natural efforts. In some cases of binovular twins with independent placentæ, the first after-birth may immediately follow the delivery of the first fœtus. This is, however, quite uncommon; as a rule both placentæ follow the birth of the second fœtus. Usually the uterine contractions cease for fifteen to thirty minutes after the birth of the first fœtus; then they return, and the second, if presenting favourably, is quickly delivered, for the passages have been already fully dilated. Occasionally a delay of many hours or even several days may intervene between the natural expulsion of the first and that of the second fœtus. A vaginal examination should be made immediately after the birth of the first fœtus to recognise the presentation of the second; if vertex or breech, nothing need be done; if transverse, external or internal version should be performed; the latter will be usually very easy on account of the small size of the fœtus and the relaxed condition of the passages. When the lie of the fœtus is longitudinal, the membranes may be ruptured artificially if the uterine contractions do not return effectively in half an hour; but a short period of rest for the uterus is natural and probably serviceable; therefore undue haste should be avoided. The delivery of the second fœtus by version or forceps can safely be accelerated as soon as labour pains have been re-established, since the passages have been already fully dilated. The *third stage* should be conducted with the greatest care and patience and everything should be in readiness for the treatment of post-partum hæmorrhage; the uterus quickly becomes exhausted, and, the area of the placental site being unusually large, the risks of post-partum hæmorrhage are increased. When dividing the cord of the first fœtus between two ligatures in the usual manner, care should be taken to tie the distal ligature securely, for if an anastomosis should exist between the two placental circulations (umbilical), the second fœtus may bleed through the cord of the first.

Twin locking is dealt with by sacrificing the first fœtus, which is usually dead, in the interests of the second, if the fœtal entanglement cannot be cleared by manipulation under anæs-

thesia. In the first variety, the lower head may be sometimes extracted after pushing up the upper head out of the way; if this fails, the first head must be perforated and crushed, for if not already dead the chances of the survival of the first fœtus are necessarily endangered, while the second fœtus has not yet suffered much from the effects of labour. In the second and third varieties, the first fœtus will almost inevitably perish; it may be decapitated, or the head perforated, and after delivering it an attempt should be made to save the second by the application of forceps or by version.

Prolapse of the Umbilical Cord and the Limbs

A loop of the umbilical cord sometimes descends below the presenting part; when this occurs before the membranes have ruptured, the condition is called *presentation* of the cord. After rupture the loop will descend into the vagina or may even protrude at the vulva; this is *prolapse* of the cord.

Causes.—Descent of the cord is more likely to occur when the presenting part imperfectly fills the pelvic brim than when the conditions are normal; it is therefore chiefly met with in presentations of the breech or shoulder, when there is pelvic contraction, hydramnios, or twins, or when the fœtus is unusually small, as in premature labour; other conditions which favour its occurrence are placenta prævia and an abnormally long cord.

Diagnosis.—The loop of the cord is easily recognised by its pulsation whether the membranes are intact or ruptured. If the fœtus is dead and pulsation has ceased, *presentation* of the cord may be mistaken for a hand or foot, but with *prolapse* no mistake is possible.

Risks.—Prolapse of the cord does not increase the maternal risks of labour, except in so far as the manipulations required for its replacement increase the risks of sepsis. The fœtus is in great danger of death by asphyxia from compression of the cord between the presenting part and the pelvic wall, or the lip of the imperfectly dilated cervix; the fœtal mortality is about 25 per cent. The risks are greater when the presentation is a vertex than in abnormal presentations, for serious compression can hardly be avoided when the head is in the brim. Descent in front of the head (anterior) is more dangerous than descent behind it (posterior), for in the latter the cord may lie near one of the sacro-iliac synchondroses and thus entirely escape compression, while in the former the loop is certain to be compressed between the head and the anterior pelvic wall. If in a flat pelvis the loop comes down at the side so as to lie in the long transverse diameter, it is very favourably placed to avoid compression. The risk is less in a multipara than in a

primigravida, for in the former labour can be terminated more rapidly. It cannot be stated exactly how long a fœtus can live after it has been deprived of oxygen by compression of the cord; but we know that the oxygen requirements of the fœtus are small, because fœtuses are often observed after birth to remain in a state of complete apnœa for as long as twenty to thirty minutes, and yet spontaneously revive and be none the worse (as happens when the respiratory centre of the fœtus has been paralysed from the effects of morphia given to the mother during labour). By analogy, it is possible that compression

FIG. 234.—The Knee-Chest (Genu-Pectoral) Position.

of the cord can last as long as twenty minutes before the fœtus dies from asphyxia.

Management.—When it is found that pulsation in the cord has entirely ceased the fœtal heart should be auscultated, and if no sounds are heard, the labour may be left to terminate naturally, as the fœtus is dead. If compression of the cord has lasted but a short time, the heart may continue to beat, but the chance of survival of the fœtus will be very small. When the fœtus is still living interference in its interest is required.

Presentation of the cord is best treated by posture. The aim of postural management is to place the patient in an attitude in which the fundus of the uterus lies at a lower level than the cervix, so that the action of gravity will promote the return of

the presenting loop into the uterine cavity. The most effectual method is to place the patient in the genu-pectoral position (Fig. 234), in which the body is supported upon the knees and the upper part of the chest, the arms being folded beneath it. Another less effectual, but also less troublesome, method is the knee-elbow position, in which the body rests upon the knees and forearms (Fig. 235). The knee-chest is more effectual than the knee-elbow position, because in the former the fundus lies at a relatively lower level than in the latter. Both of these postures are very irksome, and cannot be maintained for more than ten to fifteen minutes at a time ; the patient should then be placed upon her side, and the postural treatment resumed

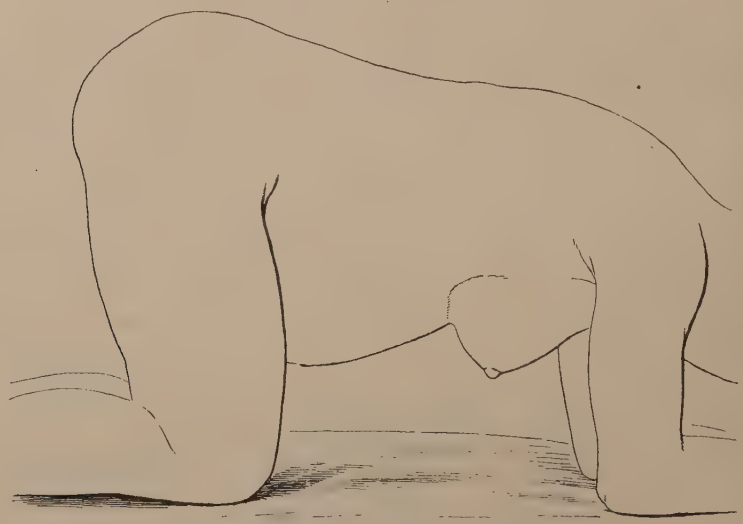


Fig. 235.—The Knee-Elbow Position.

after an interval. In hospital practice the Trendelenberg position has been employed, and with a suitable table it is possible to obtain a posture in which the patient is nearly upside down ; but it is obviously unsuitable for general use. These postures frequently fail to effect reduction. The greatest care should be taken to preserve the membranes, for while they remain intact there is little or no risk of compression. The possibility of pelvic contraction must be remembered, but no other treatment is required at this stage, as the fœtus is not in immediate danger.

Prolapse of the cord with a *partially dilated cervix* should in the first instance be treated by *digital* reposition. An anæsthetic is administered, the gloved hand passed into the vagina, and the cord then pushed into the uterus well above the presenting

part. In vertex presentation a tight abdominal binder may then be applied, to keep the presenting part well down in the pelvic brim, and so prevent recurrence of the prolapse. With the same object, in breech presentation a leg should be pulled down into the vagina. *Instrumental* methods of reposition are also sometimes adopted, but they are inferior to the digital method, for by the former a portion of the loop may easily be left in a dangerous position unknown to the operator. A simple repositor can be constructed from a piece of narrow tape and a gum-elastic catheter (Fig. 236). A suitable length of tape is boiled, and the catheter is sterilised and prepared by making a counter-opening opposite the eye; through this the ends of the tape are then threaded. The loop of tape is now made to encircle the prolapsed loop of cord and is then drawn sufficiently tight to hold it without undue compression. The catheter, along with the snared loop of cord, is next pushed up into the uterus as high as possible, and left there to be expelled with the body of the fœtus.

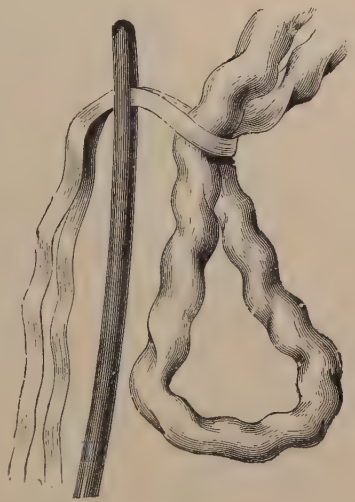


Fig. 236. – Instrumental Reposition of Prolapsed Cord. (Galabin.)

If in a vertex presentation the cervix is not sufficiently dilated to allow reposition to be properly effected, or if the cord comes down again after having been replaced a de Ribes's bag should be introduced after careful reposition of the prolapsed loop; this will effectually prevent recurrence, in addition to dilating the cervix. In a breech presentation the risk of compression is decidedly less. If the cord can be properly replaced, it is sufficient to pull down a leg and leave delivery to nature; if there is difficulty in replacing it, the dilating bag should be employed.

When the cervix is *fully dilated* prolapse of the cord should in all cases be treated by immediate delivery by version or forceps. If the head has passed the brim, the cord cannot well be replaced, nor can version be performed; rapid extraction with forceps offers the best chance of saving the fœtus.

Prolapse of Limbs.—Occasionally a vertex presentation is complicated by descent of the arm or the leg, so that the hand or foot enters the pelvic brim along with the head (Fig. 237). This occurs more frequently with premature labour or with twins, or when the pelvis is contracted, than under normal conditions. Such a presentation is usually called *complex*.

Prolapse of the foot is much rarer than prolapse of the hand. When the head is of small size, prolapse of the hand does not prevent natural delivery; if, however, the cervix is fully dilated, the hand should be replaced under anæsthesia, and the head then delivered with forceps, care being taken to avoid

Fig. 237.—Presentation of the Head and Arm.
(Galabin and Blacker.)

compression of the arm by the blades. Earlier in labour, when the cervix is incompletely dilated, version should be performed.

In a transverse presentation both the arm and the leg sometimes become prolapsed, and along with them a loop of the cord may descend. This gives a complex presentation which offers considerable difficulties in diagnosis. The treatment is version in all cases when the labour is not too far advanced for this operation to be safely performed.

(II.) ABNORMAL CONDITIONS OF THE MATERNAL PASSAGES

Pelvic Contraction

The female pelvis may be variously altered in size alone, or in size and shape, by errors of development, by local or general

bone disease, or by the results of accident. The frequency of pelvic contraction varies greatly in different localities, it being much more frequent in large cities than in rural districts. Among over 50,000 labours in the University Klinik in Vienna between 1878 and 1895, pelvic contraction occurred in 2·5 per cent. of all cases. At Queen Charlotte's Hospital, London, it was found that in 10,000 labours there were 4 per cent. of cases of contracted pelvis. A large number of different types exist, but most of them are of rare occurrence, and their effects upon the course of labour have not received detailed individual study. Three types are, however, comparatively frequent, and

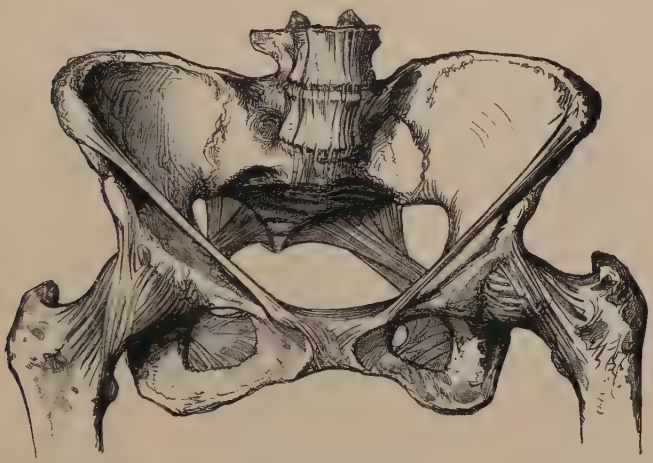


FIG. 238.—Rachitic Flat Pelvis, minor degree, showing Reduction of the Conjugate and Flattening of the Sacrum.

must therefore be fully considered; the others will be only briefly referred to.

1. The Flat Pelvis.—The characteristic features of this form of contracted pelvis are: (1) reduction in length of the conjugate diameter of the brim, and (2) an abnormal curvature of the iliac crests. Two varieties are distinguished—viz., one in which no other changes than those just mentioned are found, and one in which changes also occur in the pelvic cavity and outlet. By some writers these varieties are respectively termed *non-rachitic* and *rachitic*, the latter being attributed to rickets in all cases. By others both varieties are attributed to rickets, and they are then respectively termed the *elliptical* or *simple flat pelvis* and the *reniform flat pelvis*. The latter is clearly rickety, but the evidence upon which the former is attributed to rickets is inconclusive, and we shall therefore adopt the names *non-rachitic* and *rachitic* flat pelvis for these two varieties.

In the *non-rachitic flat pelvis* the deformity is never extreme ; the patient is usually well developed in other respects, and shows no rickety changes in any other part of the skeleton. The anterior portions of the iliac crests are not incurved to the same extent as in the normal pelvis ; consequently the distance between the anterior superior iliac spines (*interspinous diameter*) does not maintain its usual proportion to the distance between the summits of the iliac crests (*intercristal diameter*). This alteration has no influence upon labour, but is useful clinically in furnishing an indication of the condition of the pelvic brim. The conjugate diameter of the brim may be reduced to 3 inches

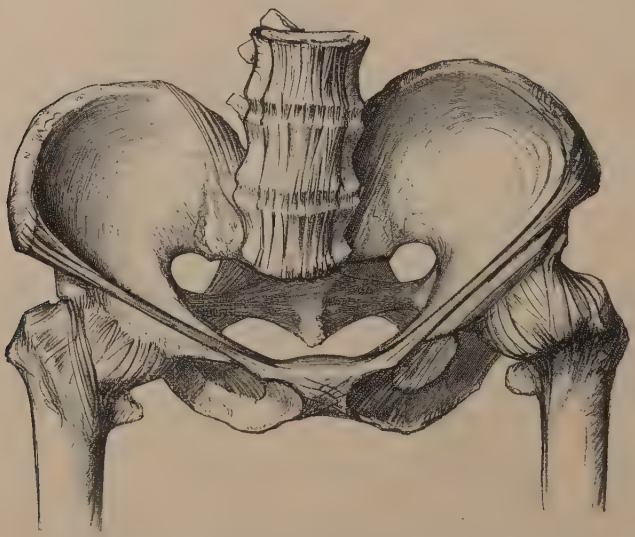


FIG. 239.—Rachitic Flat Pelvis, extreme degree : altered Curvature of the Iliac Crests.

The relative increase in the transverse diameter is well shown.

(7·5 cm.), but in this form of flat pelvis it is very rare to find a greater reduction than this. This change, to which the characteristic flattening is due, appears to be caused by slight forward displacement of the upper part of the sacrum. The transverse diameter of the brim is increased, either absolutely (over $5\frac{1}{4}$ inches), or at any rate relatively to the length of the conjugate. The oblique diameters of the brim, as well as all those of the cavity and outlet, are unaltered.

In the *rachitic flat pelvis* the deformity may be, and usually is, much more pronounced than this. Such evidences of rickets will be found as curvature of the shafts of the long bones and enlargement of their epiphyses, beading and bending of the ribs, and perhaps diminutive stature. In marked cases the pelvis

shows a series of characteristic changes. The outward displacement of the anterior portion of the iliac crests is considerable, the iliac fossæ being directed nearly forwards, instead of forwards and inwards (compare Figs. 120 and 239). The sacrum, softened by disease, has been both bent and displaced forwards by the pressure of the body-weight ; the promontory has therefore been carried nearer to the symphysis, and the concave anterior surface has become flat, or it may be even slightly convex (Figs. 238 and 239). In addition, rotation of the whole bone has occurred round a horizontal axis passing through the centre of the sacro-iliac synchondroses ; this brings the promontory still nearer the symphysis, and carries the coccyx further away from it. The *outlet* of a rachitic flat pelvis,

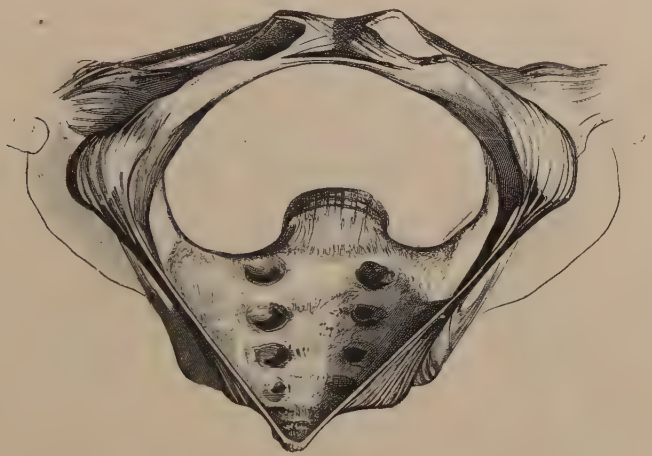


Fig. 240.—The Outlet of a Flat Pelvis seen from below.

on the other hand, is larger than normal (Fig. 240). Its antero-posterior diameter is increased by the rotation of the sacrum just described. Under the pressure of the body-weight transmitted by the innominate bones through the hip-joints to the legs, the lateral pelvic walls bulge outwards, increasing the transverse diameter of the brim ; also the ischial tuberosities are carried further apart, thus increasing the width of the pubic arch and the length of the transverse diameter of the outlet. On looking into such a pelvis from below the large dimensions of the outlet contrast with the contracted conjugate of the brim and the greatly exaggerated prominence of the sacral promontory (compare Figs. 122 and 240).

Sometimes in a rachitic flat pelvis the bodies of the pubic bones are distinctly incurved (beaked), encroaching still further upon the conjugate of the brim ; when the latter deformity is

well marked the pelvis is sometimes called, from the shape of the brim, the *figure-of-eight rachitic flat pelvis.*

The changes in a marked case of rachitic flat pelvis may be summarised as follows :

False Pelvis.—Relative increase in interspinous diameter.

Brim.—Conjugate diminished, transverse increased, shape reniform or figure-of-eight.

Outlet.—Transverse and antero-posterior increased, pubic arch widened, or in some cases narrowed (beaked).

Cavity.—Anterior surface of sacrum flat or convex.

The generally contracted flat pelvis (flat justo-minor pelvis) is a form in which diminutive size is associated with rachitic

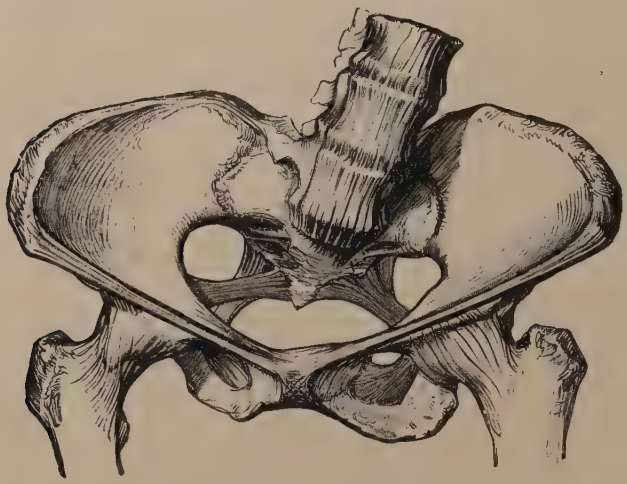


Fig. 241.—Generally contracted Rachitic Flat Pelvis, with Lateral Obliquity due to Scoliosis.

flattening ; the shape is that of the rachitic flat pelvis, but all the diameters are diminished in length. This form of pelvis is usually associated with advanced rachitic changes in the skeleton generally, one of the most frequent of these being lateral curvature of the spine (scoliosis). When this change is present the resulting pelvic contraction is asymmetrical or oblique (Fig. 241). If the spine is fairly straight, the generally contracted flat pelvis remains symmetrical. The resulting deformity is, in either case, extreme, and gives rise to more serious difficulty in labour than either the flat pelvis or the small round pelvis.

In the Vienna statistics already quoted, the four varieties —non-rachitic flat pelvis, rachitic flat pelvis, generally contracted pelvis (including pelves contracted in the outlet), and generally contracted flat pelvis, accounted for about 96 per cent. of all cases of pelvic contraction ; the

remaining varieties are accordingly very uncommon. The extreme cases of pelvic contraction met with in this country usually belong to the generally contracted flat variety.

2. The Generally Contracted Pelvis (small round pelvis : Pelvis æquabiliter justo-minor).—This form of pelvis (Fig. 242) differs from the normal mainly in size, all the diameters being *proportionately* diminished, while the general shape is preserved. Minor differences, however, exist in the inclination of the plane of the brim and in the curvature of the sacrum. The promontory lies at a level higher than normal ; and the angle made by the plane of the brim with the horizon is therefore somewhat increased (compare Figs. 120 and 242). The concavity of the sacrum from side to side is deepened, while that from above downwards is diminished ; these changes slightly exaggerate

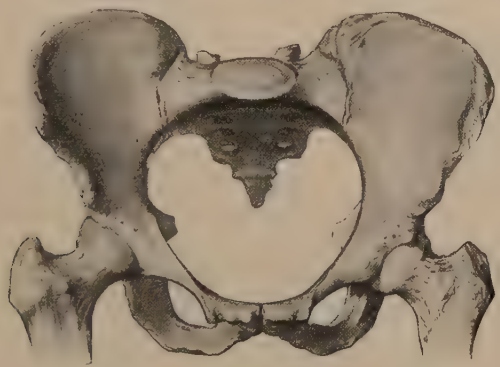


FIG. 242.—Generally Contracted Pelvis.

the diminution of the antero-posterior diameter of the cavity. All the dimensions of the outlet are proportionately reduced. The shape of the false pelvis is unaffected, but its diameters are also diminished. Sometimes pelves of this variety approximating to the male type are met with. In many generally contracted pelves the outlet is contracted out of proportion to the rest of the pelvis (see under *Funnel Pelvis*).

Nothing is definitely known of the causes of this form of pelvic contraction ; it is said to be the variety most commonly met with in America (Edgar), but in European countries the rachitic forms predominate. It may be met with in women whose development is otherwise normal ; it is also frequently found in dwarfs who are not the subjects of rickets.

3. Contraction of the Pelvic Outlet. Funnel Pelvis.—Extreme contraction of the outlet is very uncommon apart from the rarer types of pelvic deformity to be described later. Moderate contraction, sufficient sometimes to cause serious difficulties in

labour, is, however, not uncommonly met with. It must be clearly understood that by the pelvic outlet is meant the 'obstetrical outlet' or lower pelvic strait, and not merely the anatomical outlet (see p. 223). A pelvis with a contracted outlet is aptly termed a *funnel pelvis*. In many generally contracted pelves the outlet is contracted out of proportion to the rest of the pelvis. Besides these, the outlet is sometimes contracted in pelves which, in all other respects, appear to be perfectly normal; such pelves Whitridge Williams, to whom we owe a great deal of our knowledge of outlet contraction, proposes to call *typical funnel* in contradistinction to the *generally contracted funnel* pelvis. He also believes that both forms of funnel pelvis are often due to *high assimilation*, by which is meant that the fifth lumbar vertebra is fused or assimilated with the sacrum, which thus comes to consist of six instead of five vertebræ; this can so alter the relations of the sacroiliac joints that the walls of the lower portion of the pelvic cavity converge. In the majority of funnel pelves the contraction is limited to the transverse diameter of the outlet, which may be reduced to 8 cm. (3·2 inches) or less, and the ischial spines feel very prominent on palpation; exceptionally, the antero-posterior diameter also is diminished, which greatly increases the gravity of the condition.

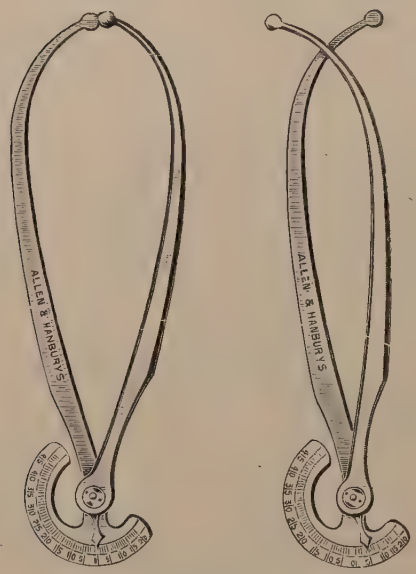


Fig. 243.—Pelvimeter.

Diagnosis of Pelvic Contraction.—While the presence of a contracted pelvis may be surmised from the diminutive stature of the patient, from general evidences of rickets or other bone diseases, from lameness, or from the pendulous condition of the abdomen in pregnancy, it can only be certainly recognised by measurement and by radiography. An X-ray photograph taken early in pregnancy, or when the patient is not pregnant, will give the best indication of the shape and outline of the pelvic brim. At term, when the bones of the fœtal skull are considerably ossified, the shadow of the pelvic bones is obscured. Actual dimensions can, however, only be estimated by pelvi-

metry, and even then, as will be explained, the estimate is only approximate. In the case of a multipara an obstetric history of previous difficult labour, in which the child was born dead or did not survive more than a day or two, should always arouse suspicion of the presence of pelvic deformity, although this will not in all such cases be discovered. The anatomical pelvic diameters described on p. 223 cannot be measured clinically, but certain other measurements of the living subject can be made, from which the size of the true pelvis may be inferred

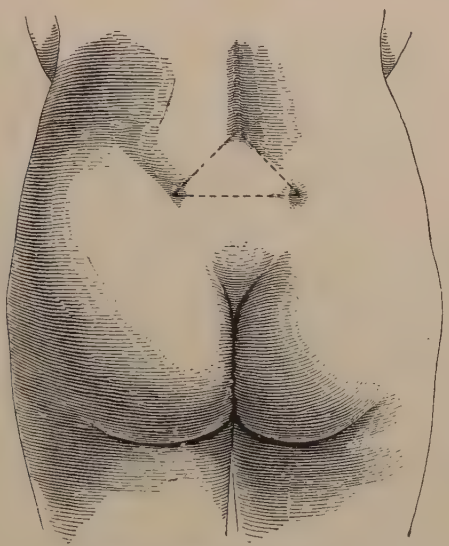


FIG. 244.—The Lumbo-Sacral Spine with a Normal Pelvis. (Modified from Bumm.)

with approximate accuracy. Such measurements must be made with great care, as it is very important for practical purposes to note the degree of contraction present in any given case.

The measurements of the pelvis which can be taken in the living subject are *external* and *internal*. They should, whenever possible, be taken with the pelvimeter; some, however, are best measured with the fingers. Methods of estimating the size of the pelvis are called *clinical pelvimetry*. The most useful form of pelvimeter for external measurements is that shown in Fig. 243. It consists of a pair of callipers, furnished with an index which shows the distance between the points in all positions. The points can be separated from each other by opening the instrument like a pair of forceps, or in the reverse direction by crossing the blades. The latter position is used for measuring the transverse diameter of the outlet by pressing

the crossed points deeply into the perineum, so as to bring them in contact with the inner borders of the ischial tuberosities. The instrument can also be used in this position for internal measurements. In using it for external measurements the instrument should be held by the points, one in each hand, and carefully adjusted to the required diameter, by firm pressure against the bone (Fig. 246). The index is then read off.

External Measurements.—(1) *Interspinous Diameter.*—This is

FIG. 245.—Estimating the Width of the Pelvic Arch by Palpation. (Williams.)

the distance between the outer borders of the anterior superior iliac spines ; its average length is 10 inches (25 cm.).

(2) *Intercristal Diameter.*—This is the distance between the outer borders of the iliac crests where these are widest apart ; the points of the pelvimeter are moved to and fro until the position of maximum separation has been found, which is usually about $2\frac{1}{2}$ inches behind the anterior superior spines. Its average length is 11 inches (27·5 cm.). From observations on the cadaver it appears that this diameter approximately represents twice the length of the transverse diameter of the brim ; and as the latter is very difficult to measure clinically, this relation becomes one of practical importance. In a normally shaped pelvis the intercristal diameter is an inch longer than the interspinous diameter. This proportion is

preserved in the generally contracted pelvis, although the length of both may be diminished, but in the flat pelvis there is less than an inch of difference between them, and in well-marked rachitic flattening the interspinous may even be equal in length to the intercristal diameter.

(3) *External Conjugate Diameter.*—This is the distance between the tip of the spine of the last lumbar vertebra and the centre of the upper border of the symphysis pubis. This diameter can be best measured in the erect position. The posterior bony point is difficult to find in fat subjects, but in thin women there is no difficulty. Whenever practicable the lumbar spines should be counted, and a palpable pit or depres-

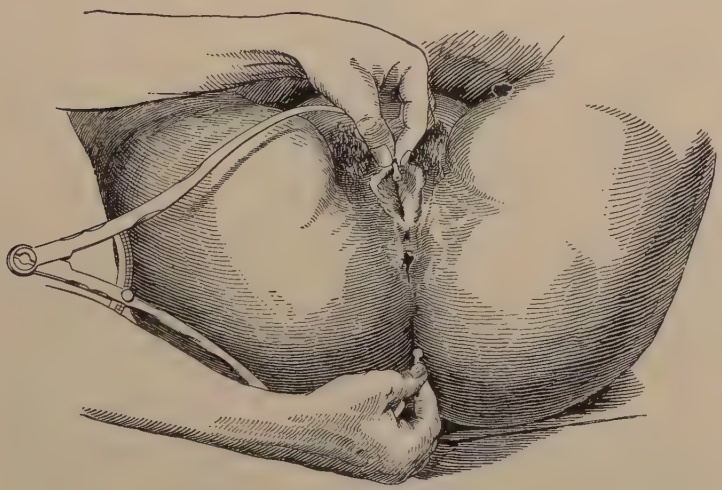


FIG. 246.—Measuring the Antero-Posterior Diameter of the Outlet. (Bumm.)

sion will usually be found just below the spine of the fifth vertebra. One point of the pelvimeter is adjusted to this depression, and the other pressed carefully and firmly against the pubes in the position described. The average length of this diameter is $7\frac{3}{4}$ to 8 inches (20 cm.). When the spine of the last lumbar vertebra cannot be clearly felt, it may be located as follows : the position of the two posterior superior iliac spines is first marked upon the skin ; these points are then united by a horizontal line ; a point $1\frac{1}{2}$ to $1\frac{3}{4}$ inches above the centre of this line will indicate the position of the fifth spine. Shallow depressions can often be recognised over these three bony points, and from them a rhomboidal figure may be constructed upon the lumbo-sacral region known as the *rhomboid* or *lozenge of Michaelis*, the lower sides being formed by the posterior

borders of the glutei maximi muscles, the upper sides by lines joining the fifth lumbar spine to the posterior superior iliac spine on each side. The relations of the three bony points to one another can, however, best be recognised by marking out a triangle upon the back as in Fig. 244 ; the base line represents the distance between the posterior superior iliac spines (*posterior interspinous diameter*). The length of the latter is variable, and consequently little importance can be attached to it ; the average is placed at 4 inches (10 cm.) in a normal pelvis.

In the case of a normal pelvis $3\frac{1}{2}$ to $3\frac{3}{4}$ inches (9·5 to 10 cm.)

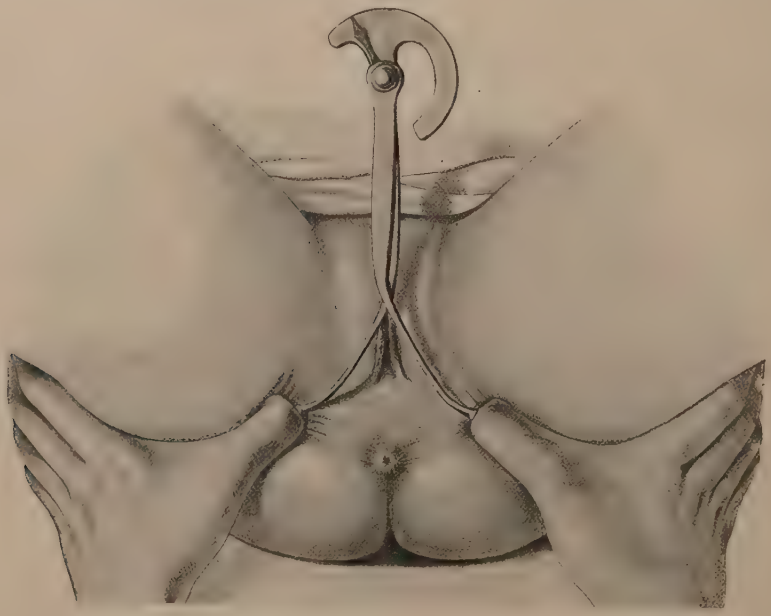


FIG. 247.—Measuring the Transverse Diameter of the Outlet. (Williams.)

must be deducted from the external conjugate diameter to obtain the true conjugate; if the pelvis is flattened, 4 to $4\frac{1}{4}$ inches (10 to 10·5 cm.) should be deducted in order to allow for the forward displacement of the upper part of the sacrum.

(4) The size of the pelvic outlet can also be measured clinically and is of considerable practical importance. The patient should lie on her back with the legs flexed and the buttocks brought to the edge of the couch. The width of the pelvic arch should first be estimated by palpation with the thumb in the manner shown in Fig. 245. After a little experience a rough estimate of the arch as *wide*, *medium*, or *narrow* may be made,

and this should be a part of the routine examination of all primigravidæ. The actual measurements need only be made when a suspicion exists of contraction. The aid of an assistant is required for these measurements. The antero-posterior is taken from the lower border of the symphysis to the last sacral vertebra, a quarter of an inch being deducted for the thickness of the sacrum (Fig. 246). In measuring the transverse diameter the inner borders of the ischial tuberosities are first defined with the thumbs (Fig. 247), and the distance measured between them.

Internal Measurements.—These can be made with the fingers alone, or with an internal pelvimeter. The most important

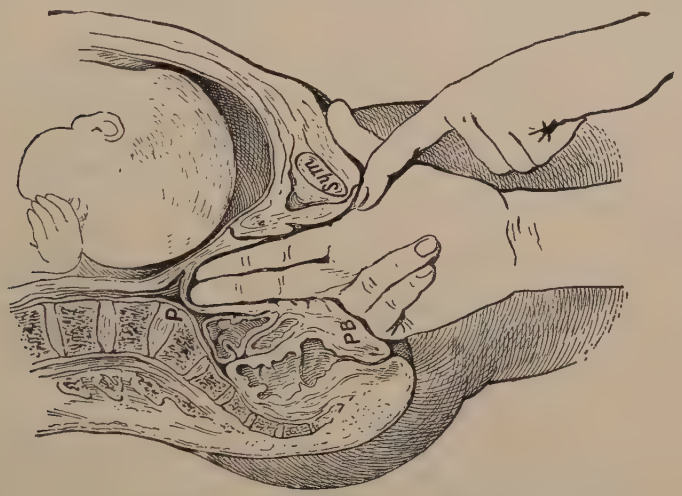


FIG. 248.—Measuring the Diagonal Conjugate. (Norris.)

diameter to be estimated by this method is the conjugate of the brim.

(1) *Diagonal Conjugate.*—This is the distance from the centre of the promontory of the sacrum to the centre of the lower border of the symphysis (Fig. 248). It can easily be measured with the fingers when the pelvic brim is considerably contracted, but it cannot be taken in labour when the presenting part is fixed in the brim. In common with other clinical measurements, it has the disadvantage that its relation to the true conjugate is variable, and difficult to estimate precisely. On an average it may be said to be from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch longer than the true conjugate—*i.e.*, $4\frac{3}{4}$ to 5 inches. The factors which affect the diagonal conjugate to an extent which it is difficult to estimate are the *thickness* and *depth* of the symphysis, and the *angle* which it forms with the plane of the brim. This measurement

can best be made with the patient lying on her back, the thighs flexed and supported by assistants, and the buttocks drawn over the edge of the bed; it can also, however, be made in the usual obstetric posture, when no assistance will be required. The index and middle fingers are passed into the vagina and pressed upwards and backwards until the edge of the promontory can be felt with the tip of the middle finger. In a pelvis of normal size it is usually impossible thus to reach the promontory. Care must be taken not to mistake the first sacral ridge for the promontory, for the diameter will then appear to be longer than it really is. When the finger is in contact with the promontory, the bone at a higher level can be felt to recede so as to become more difficult to reach; if a lower sacral ridge is touched the finger pushed further upwards is still in contact with the bone. The point where the lower border of the symphysis comes in contact with the hand is then marked off with the finger-nail, and after withdrawing the fingers the measured distance between this point and the tip of the middle finger represents the length of the diagonal conjugate. In many cases it is impossible satisfactorily to measure this diameter except under anæsthesia; this is especially the case in minor degrees of contraction.

(2) Various methods have been introduced to measure the true conjugate and transverse directly by the use of an internal pelvimeter. The simplest form of internal pelvimeter is that of Skutsch, which may be used for both the conjugate and transverse diameters of the brim. This instrument consists of a pair of callipers with one rigid and one flexible limb, joined by a screw but not furnished with an index. In measuring the conjugate the tip of the internal rigid limb is placed against the centre of the promontory, and the flexible limb adjusted to the centre of the upper border of the symphysis. The instrument is then withdrawn and the distance between the points measured off. The second measurement is taken with the rigid limb placed upon the centre of the posterior surface of the symphysis at its upper border, the flexible limb being applied to the same point as before. The difference between the two measurements represents the length of the true conjugate. In practice this instrument is difficult to work with precision, and requires an anæsthetic. Experience shows that a rough estimate of the size of the transverse diameter may be obtained by the simple expedient of endeavouring, with two fingers in the vagina, to trace the pelvic brim from the symphysis back to the promontory. If the transverse is of normal length this is very difficult, even under anæsthesia, but if contracted it will be quite practicable. This method can be controlled by halving the intercristal diameter.

Clinical pelvimetry clearly yields results which are by no

means precise. One measurement must be controlled as far as possible by others, but ultimately the carefully corrected diagonal conjugate is most to be relied upon. The most favourable moment for accurately measuring the pelvis is immediately after delivery, the patient being anæsthetised. No opportunity should be lost of taking measurements at this time in cases of contracted pelvis, so that previous diagnosis may be confirmed or corrected. For practical purposes a rough estimate of the transverse is also necessary in order to determine the shape of the pelvic brim. Photography by X-rays can be employed to show the *shape* of the pelvis with striking success except in advanced pregnancy. It is also possible by the accurate methods of radiography now practised to estimate the diameters of the brim with a fair amount of precision. But in any given case of contracted pelvis the real point of importance is not the precise length of the internal measurements, but the relation of the size of the fœtal head to the size of the pelvis. In actual practice *the only true pelvimeter is the head*, and by far the most useful method of control is the determination of the relationship between the sizes of the head and pelvis. This can be done during pregnancy as well as in labour, and is usually employed in deciding upon the mode of treatment required in pelvic contraction. This method will be described in another place (p. 388).

Pregnancy and Labour in Contracted Pelves.—The course of *pregnancy* is not affected to any considerable extent by pelvic contraction. There is no greater risk of abortion or of premature labour than when the pelvis is normal; the development of the fœtus is not affected in any way, being of average size and weight at full-time. Towards the close of pregnancy the uterus may become anteverted, causing a more or less marked condition of 'pendulous belly.' This is mainly due to the unusual height of the presenting part, which cannot enter the narrow pelvis; the level of the fundus is consequently higher than usual, and when spinal curvature is associated with pelvic contraction the forward displacement of the uterus becomes very marked. Multiparity, with lax abdominal walls and diminutive stature, still further exaggerates the anteversion. Pelvic contraction has been already alluded to as an occasional cause of incarceration of the retroverted gravid uterus at the fourth month.

The general course of *labour* is modified by pelvic contraction in various ways:

(1) Abnormal presentations are three or four times commoner in contracted than in normal pelves; the reasons for this have been already been mentioned.

(2) Prolapse of the cord is much commoner than in normal pelves.

(3) When natural delivery occurs labour is prolonged, and the mechanism is modified.

(4) Unless the true conjugate is at least $3\frac{1}{4}$ inches, even with artificial aid the survival of the fœtus is seriously jeopardised.

(5) The maternal risks are increased by the greater length and difficulty of the labour, and by the frequent necessity of employing artificial methods of delivery.

(6) The fœtal risks are increased in natural delivery by severe compression of the head during its passage through the narrow pelvis, and under other circumstances by the operations required to effect delivery, some of which involve the destruction of the fœtus.

The *clinical phenomena* are modified in several important

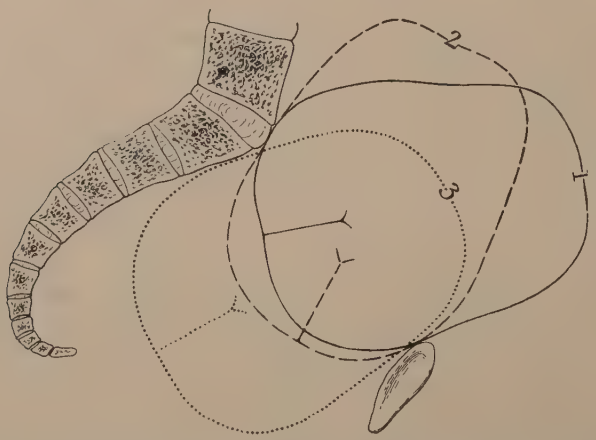


Fig. 249.—Labour in Flat Pelvis : Rotation of the Head in passing the Brim. (Clarence Webster.)

1. Well-marked anterior parietal obliquity. 2. Forward rotation. 3. Backward rotation.

particulars. When the degree of obstruction is considerable, violent uterine action may be aroused, which may either pass into *tonic contraction*, or more rarely give place to *secondary inertia*. The cervix dilates slowly, and the first stage is therefore prolonged ; the bag of waters is voluminous and frequently ruptures prematurely ; great enlargement of the anterior lip of the cervix, from œdema, may occur from the compression of the lower uterine segment between the head and the pubes. A large caput succedaneum forms in vertex or face presentations ; it may be so large as to present at the vulva before the head has passed the brim. In a rachitic flat pelvis the expulsion of the head through the vulva is often unusually rapid owing to the large size of the pelvic outlet ; in the generally contracted pelvis it is always slow and difficult.

The shape of the pelvis and the length of the conjugate are the factors which chiefly influence the course of labour. With the common varieties of contracted pelvis, in cases which are allowed to go to term, spontaneous delivery occurs in from 40 to 63·3 per cent. ; the simple flat pelvis is the most favourable in this respect, then the generally contracted pelvis, and lastly the rachitic flat pelvis. The frequency of spontaneous delivery at term diminishes rapidly in proportion to the diminution of the conjugate. Thus the Vienna statistics previously referred to show the following percentages :

C.V. . . .	9½ cm.	=	(3·8 in.)	spontaneous 75·6%
C.V. . . .	9 „	=	(3·6 „)	„ 58·7%
C.V. . . .	8½ „	=	(3·4 „)	„ 49·7%
C.V. . . .	8 „	=	(3·2 „)	„ 25·0%

Mechanism.—I. *Flat Pelvis.*—(*a*) In *head presentation* the mechanism is usually modified in the following manner, although many variations may be met with : The head enters the brim more or less extended, and in the transverse instead of the oblique diameter. Parietal obliquity (*asynclitism*, see p. 255) is usually well marked in the second stage of labour. When the contraction of the conjugate is considerable, lateral displacement of the head towards the side occupied by the occiput occurs early in labour ; this is rendered possible by the increased length of the transverse diameter, and tends to promote flexion, because the sinciput is delayed in the narrow conjugate, while the occiput, having more room, is free to descend. The result of this movement is that the bi-parietal diameter is brought into the wide lateral part of the brim, while the bi-temporal diameter engages in the conjugate. With anterior parietal obliquity (*anterior asynclitism*, see Fig. 149 (*a*)) the head passes through the brim by a movement of rotation round the *promontory* (Fig. 249). As it descends the sagittal suture approaches the pubes, bringing the posterior parietal bone first into the cavity (Fig. 249 (2)). Rotation in the opposite direction next occurs, the sagittal suture approaching the sacrum (Fig. 249 (3)), and thus bringing the anterior parietal bone into the cavity. With posterior parietal obliquity (*posterior asynclitism*, see Fig. 149 (*b*)) at the beginning of labour a similar movement of rotation round the *pubes* occurs. The mechanical advantage of this movement of rotation is indicated in Fig. 250. The lateral inclination of the head which accompanies this move-

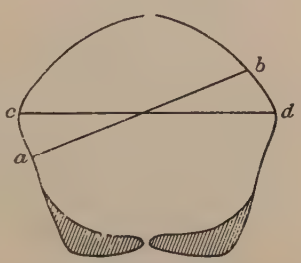


FIG. 250.—Wedge Shape of Fœtal Skull on Coronal Section. (Dakin.)

c—d. Bi-parietal diameter.
b—a. Super-sub-parietal diameter.

ment tilts the bi-parietal plane *c—d*, and brings into the brim a plane the diameter of which is indicated by *b—a*. This is the super-sub-parietal diameter, measuring about a quarter of an inch less than the bi-parietal. The widest part of the head thus escapes direct engagement in the plane of the brim. Forward rotation of the occiput will occur, if the head is flexed, when it reaches the pelvic floor. When the head has passed the brim, there will be no further difficulty in delivery unless the shoulders are disproportionately large.

If the movement of lateral displacement does not occur, as labour proceeds the head may become completely extended, the posterior part being prevented from descending while the anterior part has sufficient space for this movement. This may result in a brow or face presentation.

Fig. 251.—Posterior Aspect of Fœtal Skull: Extreme Moulding from Labour in Flat Pelvis. (Ribemont-Dessaignes and Lepage.)

The moulding of the fœtal head is modified; there is well-marked lateral asymmetry, the middle of the posterior parietal bone being much depressed; but in the longitudinal plane overriding of the bones is not excessive (Fig. 251). Often a depression or a depressed fracture of the posterior parietal bone is caused by the pressure exercised upon it by the promontory; or, after birth, a depression may be found upon the posterior parietal bone, which marks the line of compression by the promontory in the movements of lateral displacement and rotation round the sacrum.

(*b*) In *breech presentation* the mechanism of delivery of the after-coming head is modified as follows: The head engages with its occipito-frontal diameter in the long transverse diameter of the brim; a movement of lateral displacement, similar to that just described, should next occur, and be followed by a movement of flexion. Owing to the wedge shape of the fœtal skull on coronal section (Fig. 250), a certain mechanical advantage is obtained by the after-coming head, inasmuch as the narrow end of the wedge—*i.e.*, the base of the skull—first enters the brim. The bi-parietal diameter will therefore tend to be reduced somewhat by compression during its passage, and the difficulty will thus be diminished. It is probable, however, that this theoretical advantage is nullified by the fact that the after-coming head is not subjected to the process of moulding,

which in a contracted pelvis is of especial importance, by adapting the shape of the head to the distorted canal through which it has to pass. Rotation round the promontory, bringing first the posterior and then the anterior parietal bone into the pelvic cavity, will occur when the degree of contraction is considerable.

II. *Generally Contracted Pelvis.*—In this form of contracted pelvis the mechanism of labour is not greatly modified, as the proportions of the pelvis are normal. In *head presentation* the movement of *flexion* is exaggerated, reducing the diameter of engagement to the utmost possible extent. The posterior fontanelle is therefore the lowest point of the head and is readily felt on vaginal examination. The passage of the head through the outlet is rendered unusually difficult by the diminution of the antero-posterior and transverse diameters of the lower pelvic strait. In this respect great difference exists between the flat and the generally contracted pelvis.

In *breech presentation*, also, the mechanism of labour is not appreciably modified, but, owing to the reduction in length of the diameters of the outlet, displacement of the arms is very frequent, and the delivery of the after-coming head is unusually difficult; for this reason breech presentation is very unfavourable to the fœtus in a generally contracted pelvis. If extension of the head should occur perforation will be unavoidable.

FIG. 252.—Extreme Head Moulding from Labour in Generally Contracted Pelvis. (Barbour.)

The moulding of the head is of the normal type, but is extreme in degree (Fig. 252); depression and fracture of the bones are, however, more uncommon than in a flat pelvis.

Labour is more difficult in a generally contracted pelvis than in a flat pelvis with an equal length of conjugate, for the reason that the former is contracted throughout, the latter only at the brim. In the flat pelvis all difficulty ceases when the head has passed the brim; in the generally contracted pelvis the delivery of the head through the narrow outlet is the most difficult stage.

III. *Outlet Contractions: Funnel Pelvis.*—The resistance to descent begins at the level of the ischial spines; the head undergoes extreme flexion and the labour resembles that with generally contracted pelvis. In severe cases the head is arrested and becomes impacted between the ischia. The head, being

unable to pass beneath the narrowed pubic arch, has to make use of the available space behind the transverse diameter of the outlet. The distance between the tip of the sacrum and the mid-point of the line joining the ischial tuberosities is called the *posterior sagittal diameter*, and Fig. 253 (*a*) and (*b*) shows how important is the length of this diameter for the passage of the head. The posterior sagittal diameter should normally measure 10 centimetres (4 inches); its reduction below 8 cm. (3·2 inches),

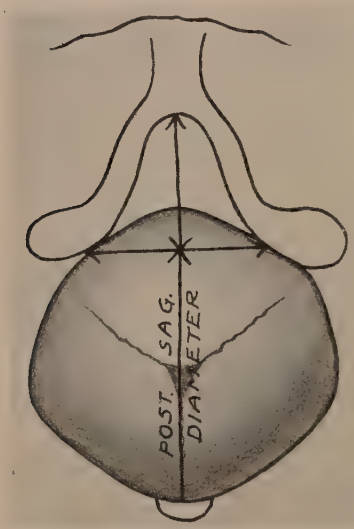


FIG. 253 (*a*).—Head passing through transversely contracted outlet. The posterior sagittal diameter is long and the head can pass easily.

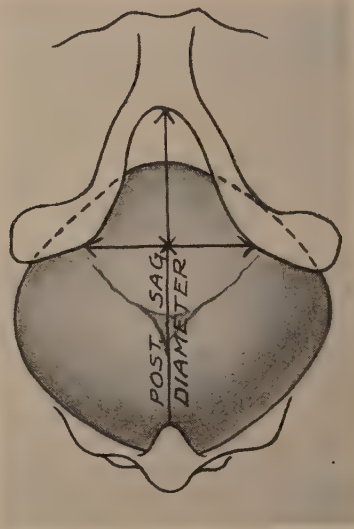


FIG. 253 (*b*).—Passage of head obstructed by outlet contracted in antero-posterior as well as in transverse diameter. Note the shortening of the posterior sagittal diameter.

associated with marked transverse contraction, will cause serious obstruction.

Management of Labour in Contracted Pelves

The size of the pelvis is the most important point to be considered in deciding upon the method of obstetric management to be applied to any individual case. The most important diameter to be considered is the conjugate of the brim, and it is convenient to arrange cases of pelvic contraction in three groups according to the length of this diameter.

A. First Degree (C.V. $3\frac{1}{2}$ to 4 inches).—It must in the first place be recognised that in this degree of pelvic contraction

there is a fair prospect that delivery at term may occur either naturally, *i.e.*, spontaneously, or with the aid of forceps. The chances of this favourable termination are greatest in the case of young women with their first three or four labours; in a primigravida the prospect is to some extent complicated by the difficulties usually associated with a first labour; it must, however, be added that pelvic contraction of the first degree frequently goes unrecognised in a first pregnancy, and is only suspected when difficulty occurs in labour. In the case of a multipara who has already had many children the prospect is also less favourable, for in such women the uterus has lost power, and is accordingly unable to accomplish that effective moulding of the fœtal head which is required if it is to pass safely through the narrow diameters of the pelvis. Unless the true conjugate diameter measures at least $3\frac{1}{2}$ inches, labour at term very seldom terminates favourably, although occasional exceptions in which a fœtus of average size has passed through a narrower pelvis than this may be met with. In the case of a generally contracted pelvis $3\frac{3}{4}$ inches is a safer limit to adopt, as the difficulties are greater than in a flat pelvis.

The reports of Queen Charlotte's Hospital show that during the seven years 1905 to 1911 one hundred and seventy-six cases of pelvic contraction of this degree were delivered in the hospital without any maternal mortality, although with some increase of the rate of *puerperal morbidity* (see p. 482). Labour at term under these conditions frequently requires the assistance of forceps, for in one hundred and seven cases forceps were required, as compared with sixty-nine cases in which delivery was spontaneous. The fœtal risks are not serious in pelvic contraction when delivery is spontaneous: in the sixty-nine cases of natural delivery all the infants survived but one, which, though born alive, succumbed to injuries received during delivery, *i.e.* the fœtal mortality was 1·4 per cent. But among the one hundred and seven cases delivered by forceps, in seventeen the child died either during labour or the first few days of life, giving a fœtal mortality for this method of delivery of 15·7 per cent.

From these considerations it is evident that when cases of pelvic contraction, in which the true conjugate is at least $3\frac{1}{2}$ inches, are allowed to go to term, labour requires judicious management, and resort should not be made to the use of forceps until it is quite evident that spontaneous delivery will not take place. Every opportunity should be given to the natural forces by moulding to adapt the head to the abnormal shape and size of the canal through which it has to pass. There are two requisites for this process—viz., a strongly and regularly acting uterus, and a prolonged second stage. Prolonged moulding by the natural forces is much less injurious to the fœtus than

the violence done by dragging an imperfectly moulded head through a contracted pelvis.

In all such cases the second stage of labour must be closely watched, and the mechanism studied with care. In the case of a flat pelvis the prognosis is considerably affected by the kind of parietal obliquity which is present ; in the anterior variety the mechanism appears to be easier, for such cases are more frequently delivered spontaneously, and are more favourable for forceps extraction than the posterior variety. The position of the sagittal suture accordingly becomes an important prognostic indication ; if this suture is found posteriorly when the

FIG. 254.—Head entering brim of a flat pelvis ; there is anterior parietal obliquity ; note position of sagittal suture and of anterior ear.

head is detained in the pelvic brim the prognosis is favourable (Fig. 254). The overlapping of the bones at the lines of suture should also be watched, and the more marked this change becomes, the better the prospect of safe delivery. When moulding is retarded by insufficiency of the contractions or by rigidity of the cranial bones, the passage of the head is rendered much more difficult. In a generally contracted pelvis parietal obliquity is unusual ; the head is generally well flexed, bringing the posterior fontanelle into a central position in the pelvis, and this point, together with overlapping of the bones from moulding, form the most important features.

A prolonged second stage is to be anticipated, and is indeed requisite for a successful result. In all cases three or four hours

may be allowed, and in many instances this may be considerably exceeded without any indication of 'fœtal distress' appearing. Careful observation of the strength and rate of the fœtal heart-sounds should be made at frequent intervals. The formation of a large caput during this period is to be anticipated, and is not a sign of serious importance. Attempts to deliver the head by the high forceps operation (see p. 638) while the head is merely engaged or but imperfectly moulded are strongly to be deprecated; serious injury to the head is almost inevitably caused by this procedure. When it is evident that the head is descending and becoming well moulded, and there are no signs of fœtal distress, the use of forceps should be withheld as long as the mother can be encouraged to continue her efforts and there is no evidence of obstetric exhaustion. Should the advance of the head cease or the pains become ineffective, forceps must be employed. In the case of a flat pelvis, when the head has passed through the brim, forceps need no longer be withheld, as delivery through the cavity and outlet will be easy. In a generally contracted pelvis the expulsion of the head becomes increasingly difficult as the outlet is reached, and forceps should not be applied till the head has reached a lower level.

The special points requiring attention in forceps delivery through a contracted pelvis will be referred to in a later section.

B. Second Degree (C.V. 3 to 3½ inches).—When the conjugate measures 3½ inches or upwards, delivery by forceps can usually be effected when labour is conducted throughout in the manner described in the last section. In the case of pelves smaller than this, failure with forceps is not uncommon, and the methods of delivery which may be practised after forceps has failed must next be considered.

If the fœtus is dead it is obvious that a destructive operation may suitably be performed and the head delivered by craniotomy. Care must be exercised in deciding that death has occurred, for mistakes are not infrequently made. If the fœtal heart has been kept under observation during the second stage, its cessation can be determined without hesitation; but if the heart has not previously been heard by the medical attendant, careful and repeated observation must be made before deciding that the heart-sounds have ceased. Other signs of fœtal distress may be present which will lend support to this conclusion.

If the fœtus is still alive the choice of the method of delivery next to be adopted is by no means an easy one, and somewhat sharp differences are to be met with in the practice of different schools of midwifery. The alternatives are delivery by Cæsarean section, and delivery through the natural passages by the aid of one of the operations designed temporarily to enlarge the pelvic canal—viz., symphysiotomy and pubiotomy.

These procedures will be described in the section dealing with obstetric operations, and their relative merits cannot be discussed profitably until the methods of performing them have been considered. It may, however, be said that the maternal risk is not appreciably greater for one than for the other, while the chance of the ultimate survival of the child is better with Cæsarean section than with the other operations. In this country delivery by Cæsarean section is regarded with the greater favour, provided that there is reasonable security that the uterus has not been infected. When the conditions are such that it is likely that infection has occurred, all operative procedures are attended with serious maternal risks, and craniotomy must sometimes be considered even if the fœtus is alive. In some Continental clinics pubiotomy is preferred to Cæsarean section.

C. Third degree (C.V. under 3 inches).—Delivery of a living and viable fœtus is impossible through a pelvis so small as this. When the diagnosis of contraction of this degree is first made during labour, Cæsarean section should be performed at the earliest possible moment. If labour has already been prolonged and the fœtus is dead, extraction by craniotomy can be performed in all but the most extreme cases (see p. 662).

Prophylactic Management.—The great prophylactic measure practised to facilitate delivery in cases of pelvic contraction is *induction of premature labour.*

Induction of Premature Labour.—The object of inducing premature labour in pelvic contraction is to avoid or diminish difficulty by arranging that labour shall come on at a time when the fœtus has not reached its full development, and accordingly the dimensions of the head are less than at term. This procedure is not attended by any appreciable maternal risk, but it has the serious disadvantage that premature infants are weakly and more difficult to rear, and often require skilled attendance for a long period after their birth. This disadvantage is naturally more serious among the poor than among the well-to-do classes, but as the great majority of cases of pelvic contraction occur in women of the poorer classes, it is undoubtedly a grave one.

Prophylactic induction must therefore stand or fall by the fœtal and infantile mortality which attends it; the procedure cannot be considered successful unless the infant not only survives its birth, but subsequently makes such progress as would give it a fair chance of life. In estimating the fœtal mortality of prophylactic induction, all cases in which the infant dies during the first fourteen days of life must be included, and there remains some doubt as to the exact proportion of infants which, being discharged, for instance, from a lying-in hospital at the fourteenth to the twenty-first day, survive the

first year of life. The later mortality, inasmuch as it could be very largely avoided by proper management, is not, strictly speaking, to be regarded as the outcome of the method of delivery.

The infant's chance of survival is influenced mainly by two factors—(*a*) the size of the pelvis through which it has to pass ; (*b*) the period of development which it has attained. To a great extent these are opposing factors, for although the smaller the fœtus the more easily it will pass through the pelvis, yet the smaller the fœtus the less chance has it of surviving. Experience of the operation shows that a premature infant of 5 pounds and upwards has an excellent chance of life ; this weight is attained under normal conditions at about the thirty-sixth week. It follows that if the pelvis is large enough to allow a child of this size to be delivered without injury, induction of premature labour may fairly be expected to be successful. Further experience has shown that unless the conjugate diameter measures at least $3\frac{1}{2}$ inches ($3\frac{3}{4}$ inches in a generally contracted pelvis), the risk of injury to the fœtus during delivery is so great as to contra-indicate induction. Therefore prophylactic induction is most likely to be successful when pregnancy has advanced at least as far as the thirty-sixth week and the conjugate of the brim measures at least $3\frac{1}{2}$ inches. Labour should not be induced before the thirty-sixth week because of the high mortality-rate of such imperfectly developed infants during the first few weeks of life. A recent investigation by Eden into the results obtained at maternity hospitals has shown that when labour was induced at the thirty-fifth week the subsequent infant mortality-rate (during the first year of life) was 33 per cent., at the thirty-sixth week 18 per cent., at the thirty-seventh week, 12 per cent., and at the thirty-eighth week 7 per cent.

Because of the unfavourable results to the infant many authorities are against the practice of induction of premature labour for contracted pelvis. Whitridge Williams, for example, states that he has never done it and does not recommend it ; he believes, with many others, that better results are obtained by allowing all patients in whom it appears indicated to go to term and performing Cæsarean section or craniotomy whenever spontaneous labour does not occur, and that spontaneous labour may be expected to occur in nearly all cases. This is known as the *expectant treatment* of contracted pelvis and is of course only applicable to cases of the *first degree* (see p. 382).

Having decided that a case is a suitable one, as regards the size of the pelvis, for treatment by prophylactic induction, the selection of the proper time for interference requires very careful consideration. This cannot be settled by definite rules, for while a fairly correct estimate of the size of the pelvis can

be made by clinical measurements, this is not the case with the fœtal head. The size of the fœtus at a given period of pregnancy is not constant, and some women habitually bear children of abnormally large size. Accordingly the proper time for induction cannot be determined by dates and pelvic measurements alone.

In every case it will clearly be of advantage to the child to allow pregnancy to continue as long as possible, and it therefore becomes necessary to form an estimate, as accurate as possible, of the relation between the size of the pelvis and that of the fœtal head. Direct measurements of the head *in utero* cannot

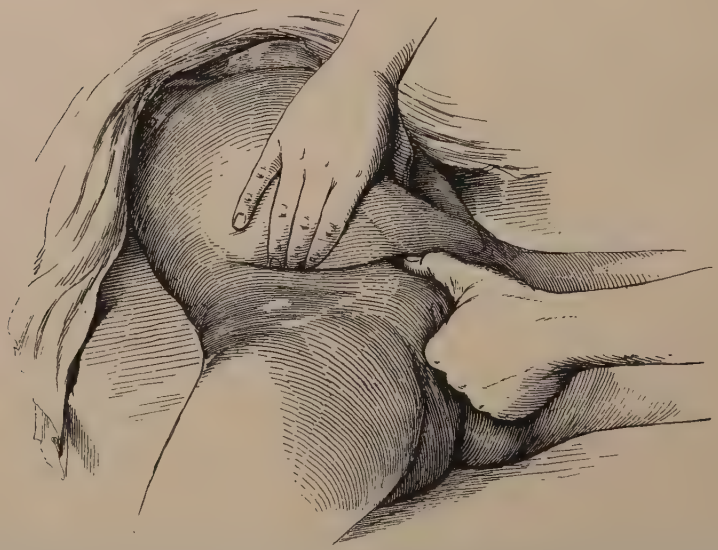


FIG. 255.—The Bi-manual Method of estimating the Relative Sizes of the Fœtal Head and the Pelvic Brim. (Munro Kerr.)

be made, and the method adopted is to determine from time to time that the head is not too large to be pushed down into the brim of the pelvis.

This estimation may be made by the *external* or the *combined* method. In either case the head must, of course, be presenting: external cephalic version must therefore be first performed if the presentation is abnormal. In stout women it is difficult to get a satisfactory result even under anæsthesia. In the *external* method the patient lies upon her back with the shoulders slightly raised upon pillows. The head is then located, and seized by the two hands in the 'first pelvic palpation' described on p. 277. Grasped between the two hands, the head is then pushed steadily down and back into the pelvis. A little

experience is required to obtain a convincing result, and the procedure is much more easily carried out under anæsthesia, which, however, must be pushed to the point of complete muscular relaxation. The *combined or bi-manual method* illustrated in Fig. 255 is that of Müller as modified by Munro Kerr ; this also can be much more easily carried out under anæsthesia. The patient lies at the edge of the couch in the modified lithotomy position, the legs supported by assistants or in a Clover's crutch. Two fingers of the left hand are then passed into the vagina into contact with the head at the brim ; the thumb is passed in front of the pubes so as to feel the upper part of the head through the abdominal wall. With the right hand the head is then pushed down into the pelvis, its descent being observed by the fingers of the left hand and the degree of overlapping of the head over the pubes being estimated by the thumb. Pressure upon the fundus by an assistant is sometimes also required. It is thus possible, in a favourable case, to determine whether the greatest diameter of the head can be made to pass into the brim.

The first estimation by these methods should be made not later than the thirty-fourth week. If it is found that the greatest diameter of the head then passes easily into the pelvis pregnancy may be allowed to continue for another week, when the manœuvre is to be repeated. As soon as difficulty is experienced in depressing the head into the brim labour should be induced. A certain amount of reduction in size may be confidently anticipated from moulding during labour.

Before definitely undertaking induction for pelvic contraction, an examination under anæsthesia should be made, the diagonal conjugate being carefully measured, and estimation made by the combined method of the relative sizes of the head and the pelvis.

Prophylactic induction is extensively practised at Queen Charlotte's Hospital under the conditions described above. In 10,000 labours there were 206 cases of induction ; among these there was no maternal mortality, but 26 of the infants did not survive ; the remainder all left the hospital doing well between the twelfth and twenty-eighth days. The maternal mortality was therefore *nil*, the combined fœtal and infantile mortality 12·6 per cent. Under carefully selected conditions it may therefore be considered that this procedure will be successful in upwards of 80 per cent. of cases.

A premature induced labour is to be conducted on the same principles as those laid down for labour at term in contracted pelvis. Instrumental interference should not be required in more than 15 per cent. to 20 per cent. of cases, and forceps delivery should never be resorted to at an early stage, for there is no doubt that extraction with forceps is more likely than a

prolonged second stage to do harm to the imperfectly ossified head of the premature fœtus.

Rare Forms of Contracted Pelvis

A. Due to disease affecting the skeleton generally.
  (1) *Osteomalacic pelvis.*
  (2) *Pseudo-osteomalacic pelvis.*
B. Due to disease of the pelvic joints.
  (3) *Naegele's* or *Oblique pelvis.*
  (4) *Robert's* or *Transversely contracted pelvis.*
  (5) *Oblique pelvis* due to disease of the hip-joint.
C. Due to disease of the vertebral column.
  (6) *Kyphotic pelvis.*
  (7) *Scoliotic pelvis.*
  (8) *Spondylolisthetic pelvis.*
D. Due to tumours of the pelvic bones.

(1) *Osteomalacic Pelvis* (Malacosteon Pelvis, Triradiate Pelvis)—Osteomalacia, or mollities ossium, produces a characteristic pelvic deformity shown in Figs. 256 and 257. The softening produced by this disease weakens the pelvic bones so much that they yield to pressure in all directions, with the result that the pelvis collapses and entirely loses its shape. The lateral pelvic walls fall in, this change becoming first apparent in relation to the anterior part of the brim in front of the acetabula (Fig. 256). This produces the characteristic ' beaking ' of the pubes. As the deformity progresses the pelvic walls may come almost in contact with one another in their anterior parts. The sacrum becomes displaced forward, the spine is curved, the beaking of the pubic bones increases, the iliac crests become twisted, and extreme deformity results, the pelvic brim being reduced to a triradiate slit (Fig. 257). In addition to the changes in the pelvis, marked deformity of the long bones and of the vertebral column occurs. Extreme degrees of pelvic contraction are caused by this disease.

It has been found that removal of the ovaries sometimes arrests the morbid process in the bones, and in consequence Cæsarean section, followed by removal of the uterus and ovaries, has been advocated as the best treatment during pregnancy. Cure of existing deformity is of course impossible, but in a certain proportion of cases the advance of the disease has been arrested by this operation. Bossi has recently reported good results in the treatment of osteomalacia by adrenalin given regularly in doses of 10 m. of 1-1,000 solution three times a day. Abortion may be induced in the early months as an alternative to the radical and curative operation.

(2) *Pseudo-osteomalacic Pelvis.*—This variety is due to rickets, and has received its name from the resemblance it presents to

ostemalacic contraction (Fig. 258). The pubic bones are slightly beaked, but the lateral pelvic walls have not yielded to

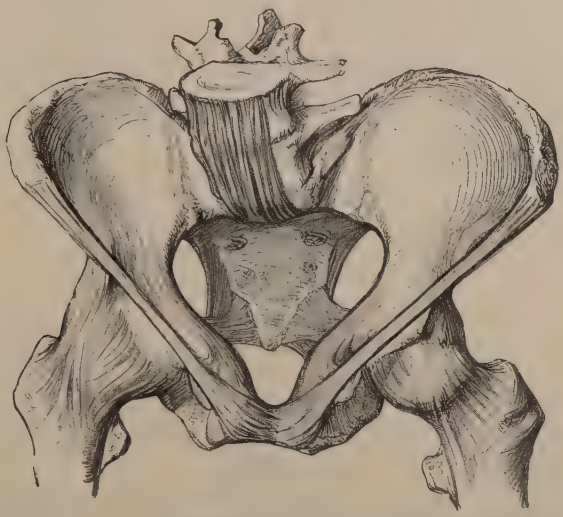


FIG. 256.—Osteomalacic Pelvis with Moderate Deformity.

the same extent as in the former variety. The anterior portions of the iliac crests are not normally incurved, so that the interspinous equals or exceeds the intercristal diameter in length.

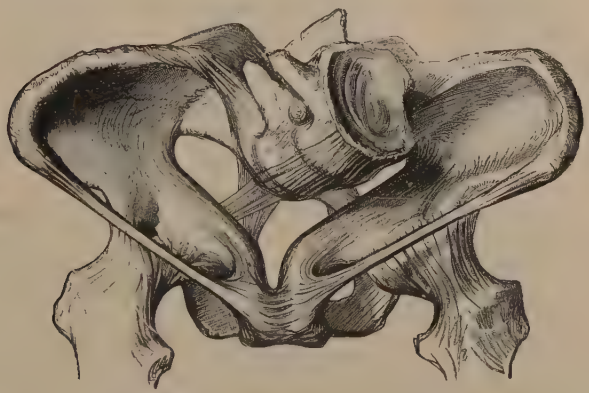


FIG. 257.—Osteomalacic Pelvis: Advanced Deformity.

Severe rickets is the cause of the deformity, and general rachitic changes in the skeleton are always associated with it. Treatment in pregnancy is governed entirely by the degree of contraction present. The recognition of this and the foregoing

variety is facilitated by the obtrusive signs of general bone disease which accompany them.

(3) *Naegele's Pelvis.*—This variety is caused by disease occurring in infancy, in or near *one* of the sacro-iliac synchondroses; as a result ankylosis with bony union of the joint occurs, and the development of the ala of the sacrum on the affected side is more or less completely arrested. The resulting deformity is shown in Fig. 259. On the affected side the ilio-pectineal line is almost straight, and the great sacro-sciatic notch is much narrower than its fellow. The symphysis pubis

FIG. 258.—Pseudo-osteomalacic Pelvis.

is displaced for $\frac{1}{2}$ inch or more to the sound side of the mesial plane of the body. The oblique diameter of the sound side (the right in Fig. 259) is considerably diminished in the whole pelvis from brim to outlet; the opposite oblique, the transverse and antero-posterior diameters, are little affected; from narrowing of the sacro-sciatic notch, the sacro-cotyloid diameter (promontory to back of acetabulum) of the affected side is very considerably less than its fellow. The distance between the posterior superior iliac spines is reduced, and the pubic arch is asymmetrical.

The diagnosis of this form of contracted pelvis is difficult. The patient is usually well developed, and may show no sign

of lameness or of general bone disease. The oblique and sacro-cotyloid diameters are very difficult to measure clinically,

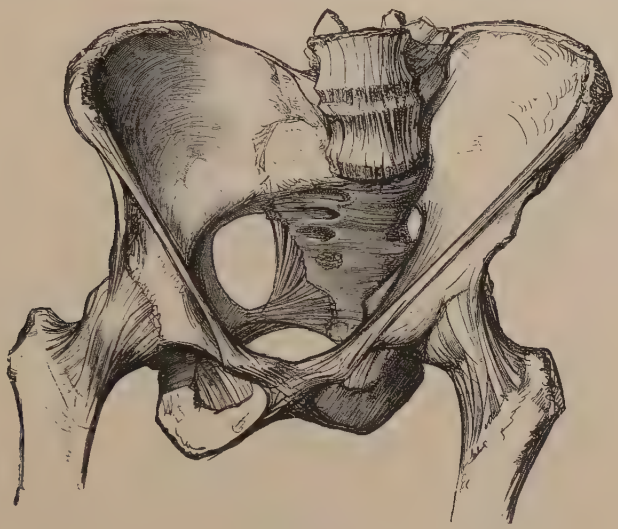


FIG. 259.—Naegele's Pelvis.

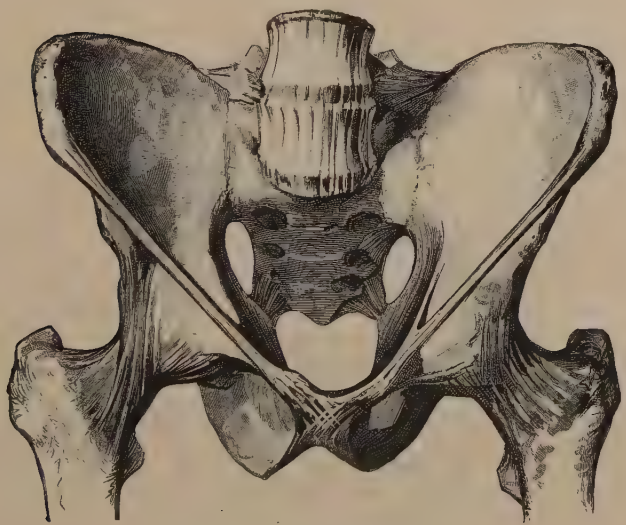


FIG. 260.—Robert's Pelvis.

and, as we have seen, the diameters which can be estimated are not greatly affected. The flattening of the lateral pelvic wall on the affected side can be recognised by careful digital examina-

tion under anæsthesia, and the lateral displacement of the symphysis pubis is a valuable indication of the condition. An

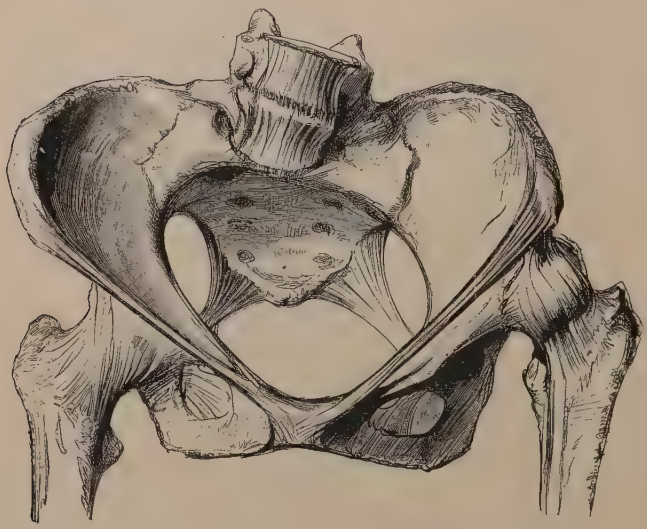


Fig. 261.—Oblique Pelvis due to Congenital Dislocation of Left Femur.

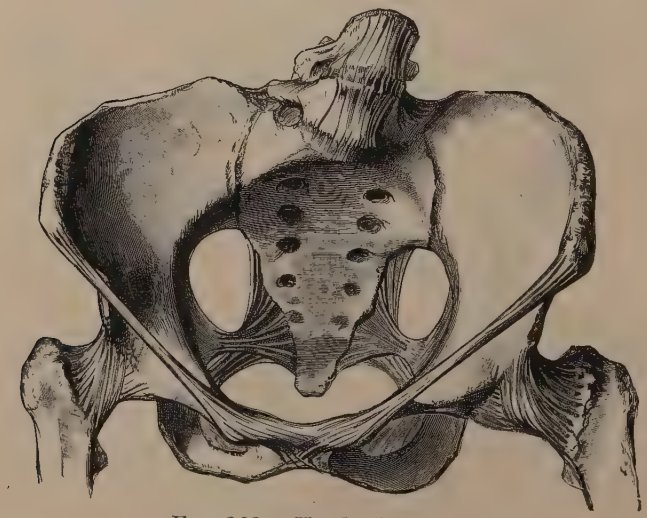


Fig. 262.—Kyphotic Pelvis.

X-ray photograph of the pelvis is the best method of diagnosis. Labour will be difficult, as the diminution in the area of the pelvic brim and cavity is considerable.

(4) *Robert's Pelvis.*—This form of pelvis is due to *bi-latera* synostosis of the sacro-iliac synchondroses, occurring in infancy ; the lesion is the same as in Naegele's pelvis, but it affects both joints (Fig. 260). The ala of the sacrum is imperfectly developed upon both sides ; both ilio-pectineal lines are nearly straight ; both sacro-sciatic notches are diminished in width. The result is a marked diminution in the transverse diameter of

Fig. 263.—The Sacrum and Lumbar Vertebræ from a Case of Spondylolisthesis. (Neugebauer.)

brim, cavity, and outlet of the pelvis ; the pubic arch also is narrowed. The distance between the posterior superior iliac spines is considerably reduced. Diagnosis is easier than in Naegele's pelvis, as the transverse diameters of the brim and the outlet can be more readily estimated than the oblique.

(5) *Oblique Pelvis due to Disease of the Hip-joint.*—Various forms of oblique deformity may be produced by subluxation of the hip (which may be uni- or bi-lateral, congenital or infantile) and by caries of the joint. Spinal curvature is

almost always associated with these lesions. The resulting lameness and deformity will direct attention to the condition of the pelvis. In Fig. 261 it will be seen that there is also well-marked tilting of the pelvis, and the flattening of the lateral pelvic wall affects the sound side, reducing the length of the left oblique diameter.

(6) *Kyphotic Pelvis.*—When kyphosis occurs in the dorsal region it is compensated by lordosis at a lower level and does not affect the shape of the pelvis, but when situated in the lumbar region it produces characteristic changes of which the most pronounced is transverse contraction of the pelvic outlet. The altered direction of the body weight draws the promontory of the sacrum backwards and upwards, causing the whole sacrum to rotate and the tip to pass forwards. The displacement of the sacrum results in a rotation of each innominate bone through an axis passing through the symphysis and sacro-iliac articulation, so that the iliac fossæ are turned outwards and the ischial bones turn inwards towards the middle line. These changes result in an extreme funnel-shaped pelvis in which the outlet is markedly contracted in the transverse diameter and to a less extent in the antero-posterior diameter; the antero-posterior measurement of the brim is increased.

Fig. 264.—Sacral Exostosis. (Galabin.)

Effect on Labour.—Owing to the lumbo-sacral curvature the ribs approach the iliac crests and thereby diminish the capacity of the abdomen, which becomes markedly pendulous at an early date of pregnancy. Abnormal presentations are therefore common. The head has no difficulty in entering the brim, but is arrested at the outlet at the level of the ischial spines. Owing to the approach of the ischial tuberosities and the narrowing of the pubic arch the head is forced backwards and may have to pass the outlet entirely behind the tuberosities (Fig. 253 (*b*)), Severe perineal tears are common. The characterisitc spinal deformity leads to the diagnosis, which is confirmed by taking outlet measurements. In extreme cases Cæsarean section is indicated.

(7) *Scoliotic Pelvis.*—Lateral curvature of the spine may produce a certain amount of asymmetry of the pelvis, one side

being somewhat more roomy than the other. Only slight degrees of pelvic contraction can, however, be produced in this

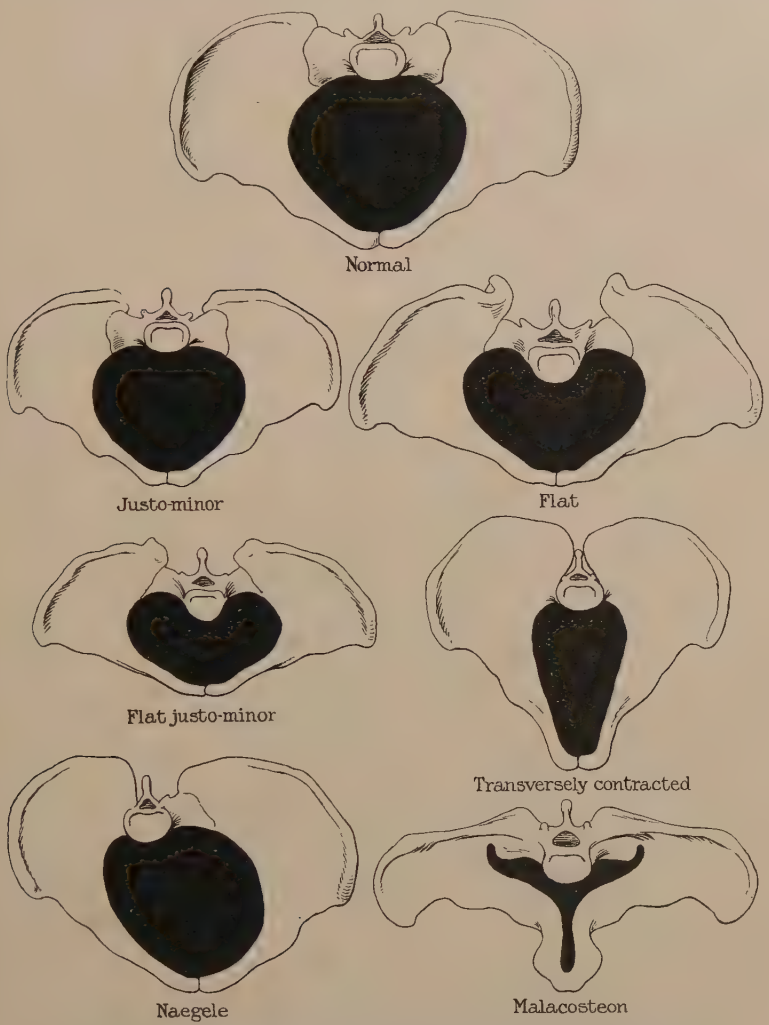


FIG. 265.—The Outline of the Pelvic Brim in the Principal Varieties of Contracted Pelvis. (Bumm.)

way. When associated with rickets, scoliosis may produce an extreme degree of oblique deformity associated with flattening.

(8) *Spondylolisthetic Pelvis.*—This extremely rare form of pelvic contraction is due to forward displacement of the body of the fifth lumbar vertebra (spondylolisthesis—σπόνδυλος,

vertebra ; ὀλίσθησις, gliding). The change which occurs is not a dislocation, but a displacement, due to lengthening and bending of the inter-articular portion of the last lumbar vertebra as a result of which the vertebra with the rest of the vertebral column becomes displaced forwards and downwards. The first sacral vertebra becomes gradually worn away by pressure, and ankylosis eventually occurs in the morbid position. The available length of the conjugate is of course greatly diminished, and as the sacrum and coccyx become rotated backwards on a horizontal axis by the pressure of the spinal column, the pelvic outlet also becomes diminished like that of a funnel pelvis. The resulting deformity of the spine is obvious, and on vaginal examination the displaced lumbar vertebræ can be recognised.

(9) *Tumours of the Pelvic Bones.*—Exostoses, either single or multiple, are sometimes found in the pelvis, the commonest positions for them being the anterior surface of the sacrum (Fig. 264) and the posterior surface of the pubes. In the latter position a small exostosis which has been overlooked may cause unexpected difficulty in labour. Cartilaginous or sarcomatous growths of large size are sometimes met with, and may cause insuperable obstruction to delivery.

Abnormal Conditions of the Soft Parts

Ovarian Tumours.—When situated entirely *above the pelvic brim*, these tumours do not give rise to much difficulty in labour, even though of very large size. They may occasion some exaggeration of uterine obliquity, and thus lead to abnormal presentations ; but in this situation they never cause obstruction. Axial rotation of the tumour, leading to serious consequences, may occur either during pregnancy or in the puerperium. The diagnosis of a large ovarian tumour in the *abdomen* as a rule is not difficult during labour ; the differential diagnosis of hydramnios has been already referred to (p. 152). Operative treatment is rarely called for in labour, and should be postponed until the patient is convalescent, unless acute symptoms arise during the puerperium.

When situated *wholly* or *partially* in the *pelvic cavity*, ovarian tumours cause serious obstruction in labour ; they then lie below the presenting part and prevent the descent of the fœtus and its passage through the outlet (Fig. 266). Spontaneous delivery, although very rare, may occur in the following ways : (1) the tumour, if cystic, may be ruptured by compression, and the collapsed cyst may then be too small to prevent the passage of the fœtus ; (2) the tumour may rupture the pelvic floor and be expelled in front of the presenting part, either through the anus or the vulva ; in such cases the pedicle

of the tumour may be torn completely across, so that when expelled, the tumour is entirely free from its attachments. If the obstruction proves insuperable and is not artificially relieved rupture of the uterus will occur.

The *diagnosis* of the presence of a *pelvic tumour* in the pouch of Douglas is easy during labour; but fibroid and ovarian tumours in this position are often mistaken for each other, for under continuous pressure a cystic tumour becomes tense and its walls œdematous, so that its consistence appears to be that of a soft solid mass, while fibroid tumours lose their naturally

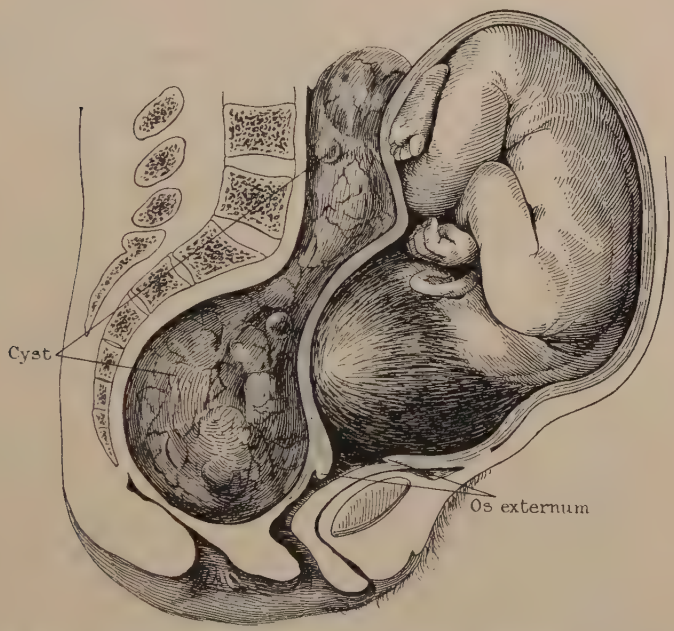


FIG. 266.—Ovarian Cyst obstructing Labour; Partial Dilatation of the Cervix has occurred. (Bumm.)

hard consistence during pregnancy. Sometimes the presenting part and the tumour enter the pelvic brim together, the tumour lying behind; care must then be taken not to mistake it for a second head.

Unless the head is fixed in the pelvic brim or the tumour is adherent it is generally possible, under anæsthesia, early in labour, to push the tumour past the presenting part above the pelvic brim, where it will cause no further trouble for the moment; but if reposition is impossible from adhesions, or from any other cause, the best treatment is immediate *ovariotomy*. The alternative method is delivery by forceps or craniotomy

(when the fœtus is dead), after tapping the tumour *per vaginam*; this is not to be generally recommended. Some tumours, *e.g.* dermoid and colloid cysts, cannot be emptied by tapping, and in multilocular cysts so much injury is caused to the tumour in dragging the body of the fœtus past it that peritonitis from bruising and rupture of untapped loculi frequently ensue in the puerperium, occasioning a high maternal mortality. In exceptional cases it may, however, be the safest expedient to adopt, as, for instance, when the unfavourable surroundings of the patient render the performance of an abdominal operation unduly dangerous. In such cases the collapsed tumour should be removed within 24 hours after labour.

Ovariotomy during labour should be performed by the abdominal route ; special care must be taken in securing the vessels. If the tumour is wedged firmly in the pelvis it may be necessary to make a very long incision and turn the uterus out of the abdomen in order to allow room to deal with the tumour ; in such cases the tumour can usually be pushed up vaginally by an assistant. Exceptionally, in cases in which the tumour is bound by adhesions or is too firmly wedged to be pushed up, it may be necessary first to deliver the fœtus by Cæsarean section. After the tumour has been removed Cæsarean section is unnecessary, for there will now be no obstacle to delivery by the natural passages. When the operation has been performed, towards the end of the first stage, the cervix being dilated, delivery can be immediately completed with forceps whilst the patient is still under the anæsthetic ; if the cervix is not fully dilated labour must be allowed to continue until it is, and then the child is delivered. The presence of a recent abdominal wound does not interfere with natural labour ; pain is relieved by morphia, and forceps is applied as soon as the second stage begins. If performed in time, the prognosis is good both for mother and child, although ovariotomy in labour is, of course, more serious than in pregnancy.

Uterine Tumours.—The two commonest forms of uterine tumour—fibromyoma in the body and cancer in the cervix—are not infrequently encountered in connection with pregnancy.

The influence exerted by *uterine fibroids* upon labour is governed almost entirely by their position. Those which occupy the lower uterine segment, or any part of the cervix, even when of comparatively small size, cause serious obstruction to delivery ; this results partly from their bulk, but mainly from the fact that they prevent the normal dilatation of these parts during labour. It is not easy, before labour begins, to tell whether a fibroid tumour situated in the lower part of the uterine body will cause obstruction or not, for such tumours, when they do not encroach upon the lower uterine segment, may, by the action of the uterus, become drawn up out of the pelvis

as labour proceeds, so as not to hinder the birth of the child. Fibroids of the uterine body which are *interstitial* give rise to malpresentation and irregular uterine action, and sometimes

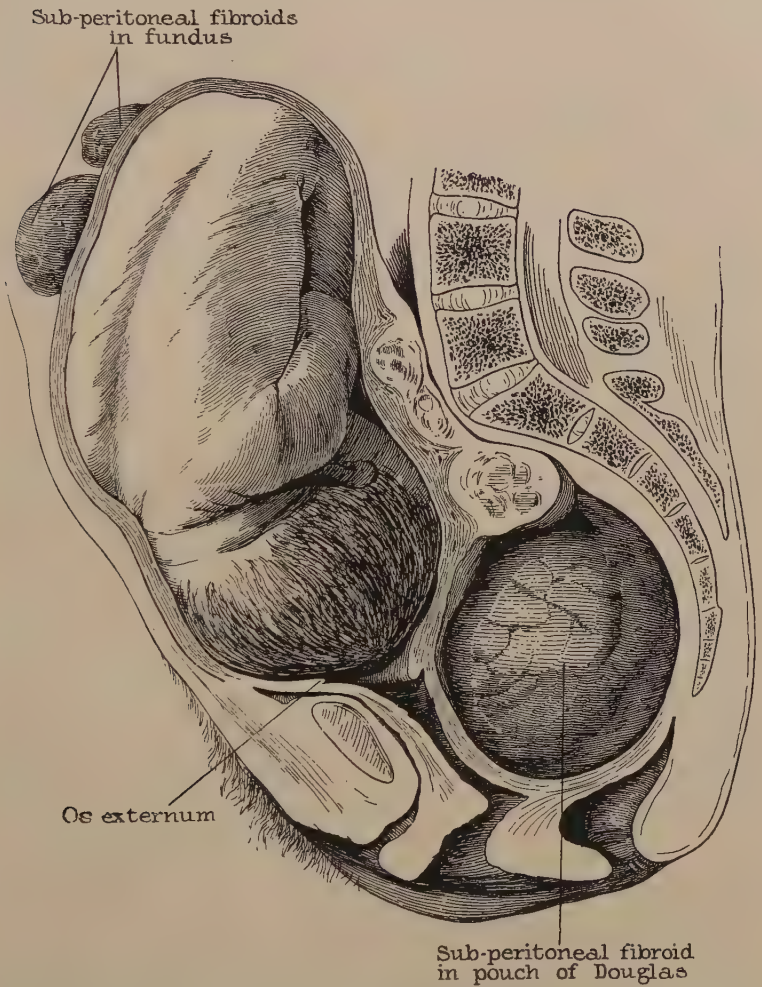


FIG. 267.—Labour obstructed by a Fibroid Tumour; Cervix partly dilated. (Bumm.)

cause post-partum hæmorrhage by interference with muscular retraction. *Sub-peritoneal* fibroids, as a rule, exert no effect whatever upon labour; but when growing from the lower part of the posterior uterine wall they may become incarcerated in the pouch of Douglas, and give rise to the most serious obstruc-

tion (Fig. 267). Fibroids in any position are liable to become infected in the puerperium if the sterility of the uterine cavity is not maintained. A uterus which contains a fibroid tumour is, however, not more likely to become infected during or after labour than one which does not. Fibroids are also liable to undergo certain degenerative changes, apart from infection, during the puerperium. *Fibroid polypi* have no influence upon labour, but may become detached and expelled during labour or in the puerperium.

Management turns entirely upon the question of obstruction. If it is clear that there will be insuperable obstruction, the best treatment is to allow pregnancy to continue and perform Cæsarean section at or near term, which may be followed either by hysterectomy (removal of the uterus) or myomectomy (removal of the fibroid). It can seldom be said, however, before labour that insuperable obstruction will result, except in the case of interstitial cervical fibroids, and sub-peritoneal fibroids which have become incarcerated in the pouch of Douglas. Fibroid tumours situated in the body of the uterus tend in all cases to become displaced upwards, and as pregnancy advances and the growth of the uterus progresses nodules which lie close together may become widely separated, and prominent ones become flattened out. In this way a tumour which is found in early pregnancy to occupy the pouch of Douglas, in a position likely to give rise to serious obstruction, may be drawn up above the pelvic brim before term is reached. In such a position obstruction is not possible, and natural labour may be awaited.

It must be understood that obstruction to labour from fibroids is rare ; neither is post-partum hæmorrhage at all common in these cases, for the reason that submucous fibroids usually prevent the occurrence of pregnancy. Labour is usually easy and uneventful. The process of dilatation must, however, be carefully watched, for the presence of only a small growth in the cervix or lower uterine segment may prevent dilatation. Cæsarean section must at once be performed when signs of obstruction declare themselves, unless the fœtus is already dead, when craniotomy is indicated. The induction of abortion for an obstructing fibroid tumour is a difficult and dangerous operation, for it may prove impossible to secure adequate dilatation, making the evacuation of the uterine cavity a matter of extreme difficulty. In consequence, this procedure is not to be advised.

Cancer of the Cervix.—Advanced cancer of the cervix is one of the most serious complications of labour which can be met with. Owing to the loss of the normal resilience of the tissues, dilatation is impossible, and spontaneous delivery can only occur after extensive laceration. The puerperium may then

terminate fatally from infection through sloughing of the lacerated tissues. Treatment consists in delivery by Cæsarean section, followed by supra-vaginal amputation of the uterus through healthy tissue in order to prevent subsequent uterine infection from the growth ; when the fœtus is dead it may be delivered by craniotomy if sufficient dilatation can be secured to render this practicable and safe.

Early cancer of the cervix often does not prevent delivery by the natural passages ; pan-hysterectomy should then be performed early in the puerperium. But in early cases delivery by the natural passages should not be allowed to occur ; the correct treatment is to perform Cæsarean section and to remove the uterus at once by a radical hysterectomy. The treatment of cancer of the cervix in pregnancy has been referred to on p. 186.

Rigidity of the Cervix.—The term ' rigidity,' as applied to the cervix during labour, has a strictly conventional significance, and may be understood to include all the conditions in which dilatation is retarded. In one class of cases the cervical tissues are to all appearances healthy, although dilatation is slow or incomplete ; this condition is called *functional* or *spasmodic rigidity* of the cervix. In another class some morbid condition of the cervix is present, to which the fault may be attributed ; this is called *organic rigidity*.

(1) *Functional rigidity* is met with in primiparæ much more frequently than in multiparæ. In all cases the cervix dilates very slowly and its tissues are abnormally firm, hence the term rigidity applied to the condition. It may arise from irregular or weak uterine contractions in the first stage of labour (*primary inertia*) ; from premature rupture of the membranes resulting in loss of the natural cervical dilator—the bag of waters ; from morbid adhesion of the membranes in the lower uterine segment, preventing the formation of the bag of waters ; from an unusual density of the cervical tissues, met with, as is believed, in elderly primiparæ (over thirty years) ; from œdema of the cervical tissues induced by compression when the pelvis is contracted, or when in a normal pelvis the vertex is extended ; and possibly, in the last place, from spasmodic contraction of muscular fibres in the cervix. It will be seen that some of these conditions are in reality abnormalities in the mechanism of dilatation.

The clinical result of functional rigidity of the cervix is prolongation of the first stage of labour, which may be delayed for many hours or even for a day or two. The mother is then, naturally, greatly fatigued, but in other respects the maternal consequences are not serious.

As long as the membranes remain unruptured there is little risk to the fœtus. Clinically speaking, cases may be divided

into two groups : those in which the pains are weak, and those in which the pains are strong. In the former, primary uterine inertia (see p. 408) is also present, and is an important factor in causing the difficulty in dilatation ; in the latter the uterine action is normal.

Treatment depends in the main upon the cause. If the action of the uterus is at fault, the treatment is the same as that of primary uterine inertia. On the other hand, if the pains are strong, repeated inhalations of chloroform sufficient to produce only slight anæsthesia, and the administration of chloral or bromide in repeated small doses, are useful remedies. But the most useful of all is the hypodermic injection of scopolamine and morphine, as described on p. 291. In the spasmodic variety, it is said that local application to the cervix of a 10 per cent. solution of cocaine is useful, but the recognition of this variety is difficult. If these means are unsuccessful, dilatation must be assisted, and as this involves very little risk to the mother it should not be postponed until she is tired out. If the external os is about two-thirds dilated and the head presents, the patient should be anæsthetised, dilatation completed by the fingers, and forceps at once applied. In a breech presentation a leg should be pulled down. If, however, the cervix is less than two-thirds dilated a de Ribes's bag should be introduced : this will, as a rule, dilate the cervix in an hour or two, and delivery can then be effected.

(2) *Organic rigidity* of the cervix may be due to adhesion of the lips of the os externum to one another (atresic condition), to precedent operation, *e.g.*, amputation of cervix, to small size of the os externum (*pin-hole os*), to hypertrophic elongation of the cervix, to cicatrices, or to the presence of a small cystic or solid cervical tumour. Fibroid and malignant cervical tumours, already considered, may also be regarded as causes of organic rigidity. *Small size of the os externum* in a primipara sometimes leads to a curious form of partial dilatation of the cervix, in which the whole of the cervical canal becomes fully opened up except the os externum itself. The head descends low into the vagina, the wall of the cervix is tightly stretched over it, and may be mistaken for the unruptured bag of waters if the small aperture representing the os, and situated upon the lowest part of the bulging swelling, should be overlooked. If in such a case the uterine pains are strong, transverse rupture of the anterior wall of the cervix may occur (Fig. 268). *Small tumours* should be dealt with by *removal ;* the other conditions may be treated either by *incision* or by some method of *artificial dilatation.* Incision is probably the best treatment for all but hypertrophic elongation, which must be dealt with by artificial dilatation. In making incisions an anæsthetic is required, and strict asepsis is necessary ; a Sims speculum should be passed to

expose the cervix, and with scalpel or scissors two deep incisions should be made through the cervical tissues at the sides of the os, one passing backwards and to the left, the other backwards and to the right. An interval of an hour or two should be allowed in order to see if the uterine contractions will now complete the dilatation naturally. If this does not occur the dilatation should be completed with the fingers, under anæsthesia, and forceps applied. If

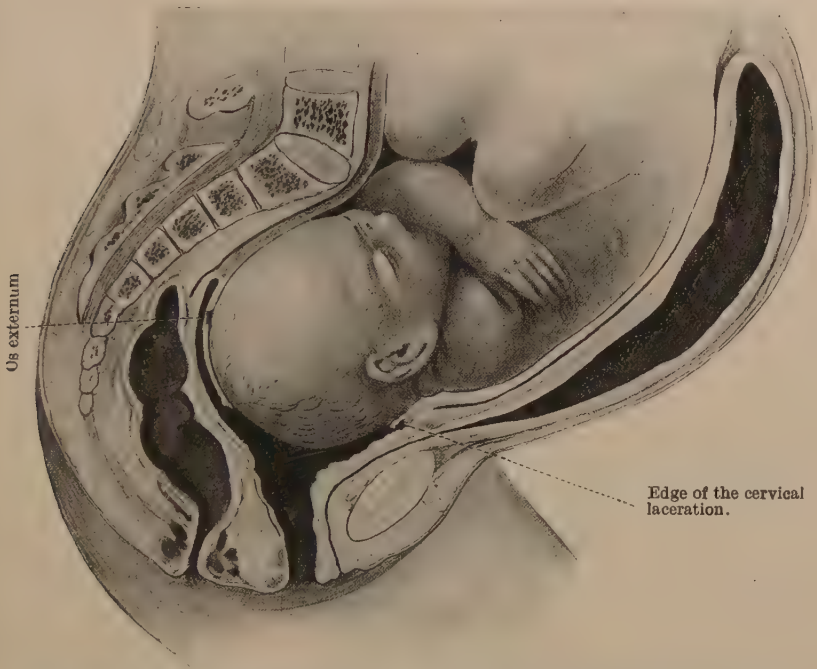


FIG. 268.—Transverse Laceration of the Anterior Cervical Wall and Non-dilatation of the Os Externum. (Diagrammatic from a case at Queen Charlotte's Hospital.)

cicatrices are present, the incisions should be made through the cicatricial tissue, and dilatation then allowed to proceed naturally ; or the same methods of artificial dilatation may be employed as in the case of functional rigidity.

From the foregoing it will be observed that slow dilatation of the cervix in labour, or prolongation of the first stage, may result from a variety of conditions. The fault may be in the action of the uterus (primary inertia), or in the formation of the cervix (hypertrophic elongation, pin-hole os externum) or in the character of the cervical tissues (abnormal density), or in the absence of the bag of waters, or in œdematous swelling

of the cervical tissues from compression. Each case must accordingly be considered on its merits, and care taken to ascertain the cause.

Rigidity of the Pelvic Floor.—In elderly primiparæ (over thirty) the perineal body and the other tissues composing the pelvic floor appear to be deficient in elasticity, and, consequently, dilatation of the vulva at the end of the second stage does not proceed normally. The head may therefore be delayed for a long time upon the pelvic floor, slightly distending the

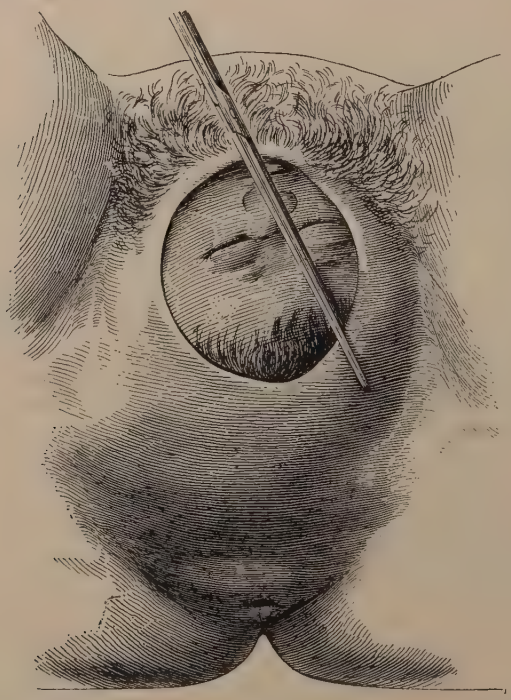


FIG. 269.—Perineotomy in a Face Presentation. (Edgar.)

vulva with each pain, but unable to escape ; unless the uterine contractions are unusually powerful, forceps will be required to extract it. On the other hand, if the uterine action is violent, the head will be driven by great force through the undilated vulva, causing a serious perineal laceration. Occasionally in such cases the vulva does not dilate at all, and a laceration then occurs in the perineal body between the fourchette and the anus, through which the head and body of the child escape. This is termed *central* or *intra-perineal* rupture. It is not always mesial in position, and the latter term is therefore preferable. Attention must be paid in all such cases to the

proper management of expulsion ; the patient should be anæsthetised and time allowed for the perineum to stretch. If a tear appears to be inevitable, two lateral incisions may be made in the anterior edge of the perineum (perineotomy or episiotomy) ; when tearing occurs it will then follow the lines of these incisions and be directed backwards and outwards away from the rectum, thus avoiding the risk of lacerating the sphincter ani (Fig. 269).

(III.) ABNORMALITIES IN THE ACTION OF THE UTERUS

Precipitate Labour.—Cases are occasionally met with in which labour proceeds so rapidly as to disturb the normal mechanism, the stages of dilatation and expulsion occurring simultaneously, or being indistinguishable from each other. After only two or three violent pains have been felt the fœtus may suddenly be expelled, and be followed immediately by the after-birth ; the whole process thus apparently occupying only a few minutes. It is difficult, however, in such cases to eliminate an element of uncertainty—viz. the possibility that uterine contractions, painless but effective, have been in progress unobserved by the patient, and have effected the usual dilatation ; the violent pains which suddenly ensue thus representing only a precipitate second stage. The conditions which lead to precipitate labour are :—excessive force of the uterine contractions, and diminished resistances in the pelvis. Nothing is known of the causes of the former ; but as instances of the latter may be mentioned an abnormally large pelvis, and the relaxed or lacerated condition of the cervix and pelvic floor, often met with in multiparæ.

Precipitate labour is unfavourable both to the mother and the fœtus. Rapid exhaustion of the uterus leading to post-partum hæmorrhage may occur, or the process of uterine inversion may be set up (see p. 437) ; also serious lacerations of the cervix and perineum may occur in primiparæ, and in consequence there is increased risk of sepsis. Owing to the fact that the patient is taken unawares, delivery may occur in the erect position and the fœtus may be killed by a fall on the floor, if the cord gives way under the strain. Many instances have occurred where it has been expelled into the water-closet. Of 800 cases of precipitate labour collated by Bayer, it was found that in only 15·5 per cent. was the patient delivered while lying down. The opportunity of treating such cases will seldom arise ; uterine action should be retarded as much as possible by the free administration of chloroform.

Uterine Inertia.—Two varieties of uterine inertia are described, *primary* and *secondary;* these are really distinct conditions which have nothing in common, but it is convenient to retain the names by which they are usually known.

(1) *Primary inertia* is a condition in which the uterine contractions are ineffective, the resistances being normal—*i.e.*, the fœtus and pelvis are of normal size, and there is no cause of obstruction. The first and second stages are greatly prolonged, and assistance in delivery is frequently required; the third stage also may be prolonged, but there is no danger of post-partum hæmorrhage because, since the uterus is capable of contracting, the function of retraction is unimpaired. The contractions may be either feeble or partial, or both feeble and partial; the intervals are usually irregular and prolonged. Sometimes the patient complains of almost continuous severe pain, but on palpation only feeble, and often partial, uterine contractions can be felt, yet these colicky contractions may appear to cause much more severe pain than the effective contractions of a normal labour.

It is met with more commonly in primiparæ than in multiparæ, and is not associated with errors of general health or development. Sometimes a disturbance of the normal mechanism of labour, such as over-distension of the uterus (hydramnios, twins), ante-partum rupture of the membranes, or malpresentation, appears to induce primary inertia. Frequently, however, no such cause can be discovered, and the condition has then been referred to defective innervation of the uterus, reflex disturbance of the action of the lumbar centre, degeneration of the uterine muscle, etc. Evacuation of the bladder or rectum, when the viscera are full or over-full, often produces a favourable influence, and it is fair to conclude that such conditions may reflexly disturb uterine contractions. Nothing is definitely known of any form of degeneration of the uterine muscle which may cause primary inertia. Unusual nervousness on the part of the patient is often observed, and may possibly in some way disturb the normal innervation of the process. The administration during labour of chloroform, morphia and other narcotic drugs often has the effect of diminishing the force and frequency of the contractions. Another factor which tends to inhibit uterine activity is the early assumption during labour of the recumbent, especially the left lateral, position.

The results of primary inertia are, as a rule, not serious either to mother or fœtus. If the mother is allowed to remain in constant pain and without sleep for twenty-four hours or longer, she will become greatly exhausted, and such cases have been known to terminate fatally. As long as the membranes remain intact the fœtus will not suffer.

Treatment.—The management of a labour complicated by primary inertia greatly taxes the strength and patience of the mother, and, it may be added, of the doctor and the nurse also. It is most important to reassure the patient and sooth her fears, for these patients are usually very nervous. The general indication must be said to be to postpone operative interference as long as possible; the temptation to expedite matters by some operative method must be resisted until time has been allowed for the natural forces to advance the course of labour as far as they can. Then comes the moment at which interference is proper and desirable.

During the *prolonged first stage*, what the patient suffers from most is fatigue and want of sleep. Sedatives must therefore be administered. Chloral hydrate and bromides do not always exert sufficient influence upon the uterine contractions to allow of sleep. A quarter of a grain of morphine given hypodermically will usually give one to three hours' sleep, after which labour may progress satisfactorily, and no further treatment be required. The best method of dealing with primary inertia, however, is the scopolamine-morphine narcosis described on p. 291; when the cervix is fully dilated forceps may be used under light chloroform anæsthesia.

In rare cases some artificial method of aiding dilatation will also be required; if the cervix is less than two-thirds dilated the use of a de Ribes's bag is probably the best method; if two-thirds dilated or more, and the pelvis is of normal size, dilatation may be completed with the fingers under anæsthesia, and the forceps at once applied. Digital dilatation of the cervix is an operation by no means devoid of risk (see p. 598); it should not be lightly undertaken, and in performing it great care and strict antiseptic precautions are required. When used merely to complete the natural process of dilatation there is not much risk of serious injury.

Many attempts have been made to excite stronger and more efficient contractions by stimulation of the uterus, but these are all unreliable, and need not be described. It should not be forgotten that a distended bladder or a loaded rectum often exerts a very unfavourable influence upon uterine contractions, and the condition of these organs must not be overlooked.

The *second stage*, if allowed to proceed without interference, will also be very protracted. But it is not necessary to await the expulsion of the fœtus by the natural efforts, if the presentation is a vertex and no cause of obstruction exists; labour may then be terminated by forceps as soon as dilatation of the cervix is complete. With a breech presentation delay may be desirable in the interests of the child.

(2) *Secondary inertia* or *atony* is in reality *exhaustion* of the uterus, and is a rare condition; it is marked by a complete

cessation of uterine action, bringing the process of labour to a standstill ; the functions of contraction and retraction are both in abeyance ; in this important respect it differs essentially from primary inertia. The labour usually begins normally with satisfactory or even unusually vigorous pains, but they soon die away, either rapidly or gradually ; in other words, the uterus is capable of acting normally at first, but cannot maintain its action for a sufficient time to terminate labour. It may occur at any stage of labour—rarely in the first, more frequently in the second and third ; it may also supervene suddenly when labour is entirely over, resulting in the complete loss of the power of *retraction*. It occurs mainly in multiparæ, and is found especially in those who have had a rapid succession of pregnancies. It may occur during the long and difficult course of an obstructed labour. It is predisposed to by shock, by the extreme anæmia of ante-partum hæmorrhage, and by prolonged and deep anæsthesia. There is no doubt that it depends upon some defect, either in structure or in innervation, of the uterine muscle ; the nature of this defect is, however, unknown. The complete atony of the uterus suggests a temporary paralysis of the nerve centres which govern uterine activity. No harm, either to mother or fœtus, follows its occurrence during the second stage, for the head may remain for many hours in the pelvis, when both are of normal size, without injurious effects. After a more or less prolonged interval the pains usually return and labour terminates naturally. When inertia occurs after the expulsion of the fœtus, serious hæmorrhage results, owing to the fact that the exhausted uterus is unable to retract.

The *treatment* during the first or second stage is to procure sleep by the administration of morphia or chloral. After a period of sleep uterine pains will probably recur spontaneously, and labour should then be terminated as rapidly as possible, or the uterus will again become exhausted. The temptation to deliver with forceps in the total absence of uterine contractions must always be resisted. It is a cardinal rule of obstetrics that delivery should never be effected by artificial means in secondary inertia, for the most serious and uncontrollable post-partum hæmorrhage may result from a breach of this rule. The treatment of secondary inertia in the third stage and after labour is considered on p. 472.

Minor degrees of secondary inertia may be successfully treated by drugs during the second stage. The most useful is pituitary extract, the effect of which in stimulating the uterine muscle has been already alluded to.

Over-action of the Uterine Muscle.—This condition is the opposite of inertia ; both the functions of contraction and retraction are, or may be, exaggerated as the result of excessive

stimulation. Three varieties of this condition are to be described :—

(1) Excessive uterine retraction, leading to over-stretching of the lower uterine segment and formation of an exaggerated *retraction ring.*

(2) General tonic contraction of the uterus.

(3) Local tonic contraction of the uterus leading to a *contraction ring.*

(1) *Excessive retraction* may be considered first as being the simplest of the three varieties. It results from mechanical obstruction to delivery, in consequence of which the upper active part of the uterus makes violent efforts to overcome the obstacle. Retraction and shortening of the upper part gradually attains an extreme degree, while the lower passive part simultaneously becomes lengthened and attenuated. Consequently the level of the transition from active to passive parts is marked by an abrupt change in thickness of the wall, forming an unusually well-marked 'retraction ring.' It is therefore an exaggeration of the normal action of the parturient uterus, and is seen in cases of obstructed labour, representing an attempt to overcome some serious mechanical obstacle to delivery. It will be further referred to in a later section.

(2) *General Tonic Contraction.*—This condition, on the other hand, represents, not an exaggeration of normal function, but a perversion of function of the uterus. The physiological differentiation of the uterine body into an upper active and a lower passive portion (lower uterine segment) is lost, and pronounced retraction occurs in the whole of the uterus, with the exception of the part below the internal os. In an extreme case intermittent contractions cease, and the whole organ passes into a condition of tonic muscular spasm or tetanus.

It results from irritation or over-excitation of the uterus during labour, and only very powerful stimuli, in operation for a long time, can cause it. Thus it may occur during labour from two main causes : (1) from the unsucccessful efforts of a powerfully contracting uterus to overcome obstruction ; (2) from the irritation caused by repeated unsuccessful attempts at artificial delivery. It has also been attributed to the administration of ergot, either at an unsuitable time or in over-doses, but it is doubtful if this drug alone can produce it. In the worst instances the two first-named causes are both present. It involves the most serious risks to the mother and fœtus.

Complete tonic contraction is characterised *clinically* by severe and continuous pain, leading after a time to rise of temperature and quickening of pulse. The liquor amnii is completely expelled, the placenta becomes compressed against the body of the fœtus, and the latter will consequently in a short time perish from asphyxia. Intermittent contractions have

ceased, and on abdominal examination the uterus will be found to be small, tender to the touch and continuously hard, so as entirely to obscure the outlines of the fœtus on palpation. As the fœtus is dead, the heart-sounds have ceased. On vaginal examination the presenting part will be found immovable and covered with a very large caput succedaneum ; if the condition has persisted for some time the vaginal and vulval mucous membranes will be found swollen, dry, and tender. Cases so severe as this are seldom met with except where repeated unsuccessful attempts at delivery by version or forceps have been made, the irritation caused by the repeated introduction of the hand or the instrument into the uterus being the direct cause of the tetanus. If unrelieved, rupture of the uterus may occur.

The *diagnosis* of general tonic contraction presents no difficulty ; it is impossible, with ordinary care, to mistake it for secondary inertia, a condition in which pains are absent and the uterus is relaxed.

The *treatment* of both forms of tonic contraction is the same (*vide infra*).

(3) *Local Tonic Contraction.*—In this condition an annular area of the uterine wall passes into tonic contraction, while the parts above and below it continue to play their normal physiological part. In other words, the upper part contracts intermittently, while the lower part is relaxed. The consequence is that a narrowing of the lumen of the uterus occurs at the affected part, the constriction being of a dense and highly resistant character (Fig. 270). This annular constriction may be termed the *contraction ring*, to distinguish it from the *retraction ring* already described in connection with the physiology of normal labour. The contraction ring is always situated in the lower part of the body of the uterus, and apparently above the level of the internal os. It is largely owing to the recent work of British obstetricians that this form of tonic contraction has been recognised and understood. The causation of this variety is similar to that of general tonic contraction, but may be regarded as the response to a less powerful irritation. Cases have been recorded in premature rupture of the membranes in which no obstetric interference had been practised, after intra-uterine manipulation, after malpresentation, uncorrected for a long time, and after uterine infection during labour. In the great majority of cases the ring has been observed during the second stage of labour ; in some instances during the third stage, when it obstructs delivery of the placenta ; one case has been observed in which it formed during the first stage, the membranes being intact. When occurring in the third stage it gives rise to the condition known as ' hour-glass contraction ' (p. 468).

The effect of the contraction ring is completely to obstruct

the further advance of the fœtus. As a rule the ring is found to be firmly moulded upon some relatively small part of the fœtal body, such as the neck in head presentation, or a limb in shoulder and breech presentations. In a few cases it has formed altogether below the presenting part, the entrance of which into the brim has thus been effectually prevented. In either case

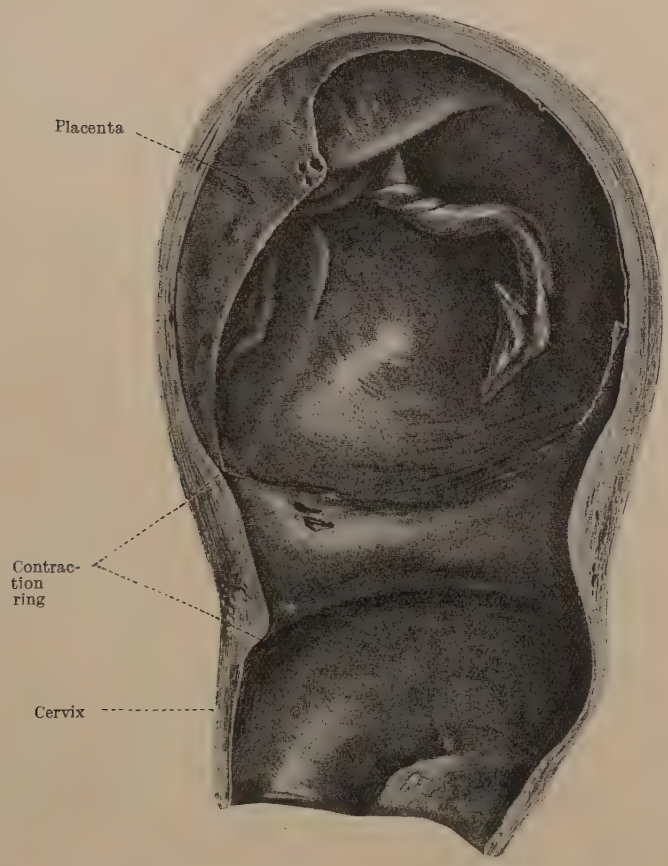


FIG. 270.—Local Tonic Contraction of the Uterus.
(Clifford White.)

labour is brought to a standstill, and further progress is impossible until the condition has been relieved.

The diagnosis of the *contraction ring* is made by finding the constriction on vaginal examination. The general condition of the patient, as a rule, remains good, temperature and pulse being normal ; in this respect the distinction from general tonic

contraction is well marked. On abdominal examination the greater part of the uterus still shows intermittent contraction, and during the intervals of relaxation the position and parts of the fœtus can be made out. The presence of the ring is not recognisable, as a rule, on abdominal examination. On vaginal examination the condition will escape notice unless the fingers are passed well up above the presenting part, except in rare instances in which the ring forms below it. Examination under anæsthesia to discover the cause of the delay in labour will permit of palpation being effectually carried out. Care must be exercised in attempting to pass the fingers through the ring, as rupture of the uterine wall may easily be caused.

The *treatment* of both varieties of tonic contraction may now be considered.

(*a*) *General Tonic Contraction.*—This condition offers the greatest difficulty to delivery by the natural passages. The fœtus is invariably dead, and treatment can therefore be regulated entirely by the maternal interests. Owing to the non-differentiation of the uterus into active and passive portions, the muscular spasm tends not to expel the fœtus, but to hold it tightly in position. This effect has been aptly designated by Eardley Holland ' active retention of the fœtus.' This force, which is very powerful, must be overcome before the child can be extracted.

Many attempts to cause relaxation of the muscular spasm have been made, but with constant ill-success. Full doses of morphia aided by chloroform anæsthesia fail as a rule, and owing to the serious constitutional symptoms which are present a long delay is contra-indicated. Operative measures must, therefore, be adopted in almost all cases. The most suitable method is embryotomy, but the conditions do not always permit of this being effectually carried out. If the head presents it should be perforated and crushed by the cephalotribe ; traction should then be applied to the instrument carefully and continuously, without the exercise of undue force. While traction is being applied delivery of the trunk may be assisted by division of the clavicles (cleidotomy) to diminish the width of the shoulders. In presentation of the breech or shoulder embryotomy may be very difficult to carry out, and Cæsarean section is the only alternative, followed by removal of the uterus if signs of uterine infection are also present.

(*b*) *The Contraction Ring* is to be treated upon the same general principles. The general condition of the mother being usually good, there is not the same urgency, and more time may be expended in efforts to deliver. Morphia and rest should first be tried, failing which, prolonged chloroform anæsthesia has often succeeded in relaxing the spasm. Attempts at manual dilatation of the ring and forceps delivery do not succeed, and

are dangerous because they may result in serious rupture of the uterus. When the fœtus is alive Cæsarean section may be performed. When the fœtus is dead the head should be perforated before attempting extraction. In some cases delivery has been effected by continuous weight traction (Willett); the forceps or craniotomy forceps is fixed on the head and traction is so arranged as to keep up a continuous pull until the ring relaxes.

Ante-partum Rupture of the Membranes. — When intra-uterine tension is considerably increased during the later weeks of pregnancy, as in twins or hydramnios, or when from unusual opening up of the cervix before labour the lower pole of the ovum is unsupported, or when from any cause the chorion and amnion are unusually weak, rupture of the bag of waters may occur before labour has begun. This is known as ante-partum or premature rupture of the membranes. It is met with chiefly in hydramnios, multiple pregnancy, and presentation of the breech or shoulder. The immediate result is the escape of liquor amnii; this usually occurs slowly, but large quantities may be gradually discharged, the flow being usually intermittent, and corresponding with the involuntary uterine contractions. Ultimately labour supervenes; but several days may elapse before this occurs, and even intervals of several weeks are not very uncommon. If the fluid is in considerable excess, no harm will follow from the escape for several days, for sufficient will remain in the uterus to protect the fœtus from injurious pressure.

With regard to *diagnosis*, one point only requires mention —viz., that, after ante-partum rupture of the membranes and escape of a good deal of fluid, the examining finger may still detect the presence of a small lax bag of waters below the presenting part. This may be explained by the fact that in such cases the point of rupture is not the lower pole of the membranes, but some point higher up, the fluid escaping from the amniotic sac and finding its way between the chorion and the uterine wall into the vagina. Again, in rare cases, small quantities of fluid may be present between the chorion and the amnion, which may escape by rupture of the chorion, the amnion remaining intact. In this case, also, a bag of waters will be found, but the quantity of fluid lost in this way is always small.

The course of *labour* is often unfavourably influenced both as regards the mother and the fœtus. Owing to the absence of the natural cervical dilator (the bag of waters), the first stage may be prolonged and made difficult. But if a fair-sized bag should remain, this difficulty will be in great part obviated. From the coincident over-distension of the uterus primary inertia is frequently met with. Infection of the amniotic cavity by pathogenic organisms, from a morbid vaginal secretion, or introduced from without by vaginal examination, may occur. In

some such cases the liquor amnii becomes offensive, but this is not invariably the case ; fever and other signs of sepsis may form the earliest indication that intra-uterine infection has occurred. The fœtus invariably perishes under such circumstances, or the child succumbs to infection shortly after birth. Further dangers to the fœtus are that the cord or a limb may prolapse, or that the uterus may close down upon it when all the liquor amnii has escaped, and by compression of the placenta lead to death from asphyxia.

Management.—When rupture of the membranes occurs before labour, interference is not immediately indicated, for there is no danger to the fœtus until the whole of the liquor amnii has drained away. In many cases labour will begin spontaneously within a day or two, although much longer intervals often elapse. The patient should be kept in bed, or at least lying down, and careful examination should be made daily to determine (1) the amount of liquor amnii which remains in the uterus ; (2) the condition of the fœtal heart-sounds ; (3) the absence of signs of infection. The degree of mobility of the fœtus and the girth of the abdomen are the best guides to the amount of fluid present ; while the heart-rate remains between 120 and 140 no harm from compression need be feared, but a steady or continuous rise or fall of the rate, above or below this level, forms an important danger-signal.

It is best to induce labour in two or three days, even if there are no signs of fœtal distress ; but this should be done at once if evidence either of fœtal compression or of uterine infection is obtained earlier than this. The best method to employ is the introduction of the de Ribes's bag ; this instrument not only dilates the cervix and excites uterine pains, but also prevents further escape of liquor amnii by plugging the lower segment and cervix. The cervix is usually sufficiently dilated to admit the dilator in these cases, but if not it must be previously stretched to the required size (see p. 594).

(IV.) OBSTRUCTED LABOUR

This term may be conveniently applied to *cases in which spontaneous delivery through the natural passages is impossible.* A considerable number of different conditions, which may be tabulated as follows, may cause obstruction in labour, although all of them do not invariably produce that result :

I. *Maternal Conditions.*

Pelvic contraction.
Tumours of the pelvic bones.
Ovarian and uterine tumours.
Undilatable atresia of the cervix or vagina.

II. *Fœtal Conditions.*

Brow presentation.
Face presentation with backward rotation of the chin.
Transverse presentation.
Locked twins.
Certain fœtal developmental anomalies :
(*a*) Hydrocephalus.
(*b*) Gigantism or post-maturity.
(*c*) Abdominal tumours or ascites.
(*d*) Double monsters.

The maternal conditions and the mal-presentations named in this list have been already considered. The remaining fœtal conditions may be briefly referred to before considering the clinical results of obstructed labour. It will be observed that while in hydrocephalus the difficulty will be to deliver the *head*, in the conditions named after it the difficulty will be in delivering the *trunk*.

Hydrocephalus.—This condition consists in an enlargement of the head due to an accumulation of fluid ; in the great majority of cases this accumulation occurs in the cerebral ventricles (hydrocephalus internus), in others it occurs in the sub-arachnoid space (hydrocephalus externus). The amount of fluid present, and the consequent enlargement of the head, ranges widely in different cases. A case has been recorded by Anton in which the cubic capacity of the skull was found to be 8,300 c.c. ($14\frac{3}{4}$ pints) ; amounts of from two to three pints have frequently been withdrawn from the head after puncture or perforation during labour. It is obvious that a degree of obstruction sufficient to cause serious difficulty in labour would result from the presence of a much smaller amount of fluid than this, and as a hydrocephalus of moderate size is more difficult to recognise before birth, such cases often give rise to more trouble than those of the largest size.

The hydrocephalic head is more or less globular in shape, the brow protuberant, the face of relatively very small size ; the cranial bones are poorly ossified, as a rule, thin and sometimes crepitant on pressure ; the sutures and fontanelles very wide. Occasionally a hydrocephalic head is found fully ossified. Other deformities are not uncommonly associated, such as spina bifida, meningocele or encephalocele, club foot, etc. The amount of brain substance present varies with the degree of fluid accumulation ; in bad cases it exists only in the form of a thin shell enclosing the fluid, and there is no distinction to be perceived between the grey and the white matter. The cerebellum and the cranial nerves are often unaffected. Minor degrees of hydrocephalus are not incompatible with the development of a normal intelligence.

The *cause* of hydrocephalus is unknown. Hereditary syphilis is regarded as a predisposing factor. The occasional occurrence of a series of cases in the same family has been observed, and if in such instances syphilis has been excluded, it suggests that heredity may be an important causal factor. Many authorities believe that pre-natal meningitis is the actual precursor of the excessive formation of fluid, the ependyma of the lateral ventricles being the parts chiefly affected; such changes can be frequently demonstrated after birth.

During *pregnancy* hydrocephalus gives rise to no complications, as a rule, and is accordingly seldom recognised. During labour it may give rise to obstruction of the most serious kind resulting in rupture of the uterus. In 109 cases of labour with hydrocephalus collated by Hohl, Schuchard and Veit, twenty

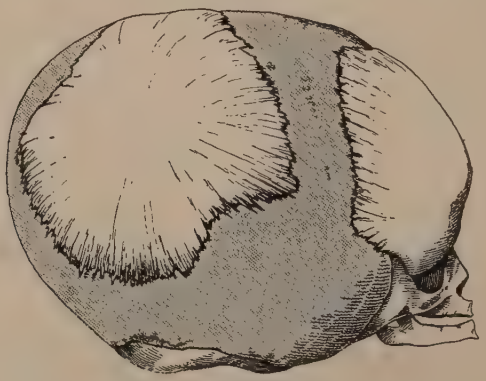


FIG. 271.—The Skull in Hydrocephalus.
(Ribemont-Dessaignes and Lepage.)

deaths occurred from uterine rupture. The difficulty of diagnosis during labour accounts for this heavy maternal mortality. Breech presentation is more common than in normal cases, but the majority present by the head. Owing to the soft consistence of the markedly hydrocephalic head the condition is by no means easy to recognise on abdominal examination, especially if the breech presents. Vaginal examination, with the head presenting, may reveal very wide sutures and fontanelles, with thin crepitant bones, but the latter sign occurring alone has no diagnostic significance, as it may be met with when the head is of normal size. Owing to the fact that the head is too large to enter the brim of the pelvis, palpation of the sutures is almost impossible early in labour, and the diagnosis can only be made by a careful bi-manual examination under anæsthesia. When the cervix dilates, and partial moulding of the head occurs, the presenting part comes

down within reach. If, however, the risk of rupture of the uterus is to be avoided early diagnosis is necessary. Accordingly, in all cases, the sign upon which reliance must be placed is the recognition by bi-manual examination of the cephalic enlargement ; anæsthesia is required for this during labour, and the bladder must, of course, be empty.

The maternal risk is greatest when the head presents, for if the condition is not recognised, over-distension of the lower uterine segment leading to rupture is very likely to occur. With the after-coming head there is less risk, as the uterine contractions are then too feeble to overstretch the lower uterine segment.

The *management* of a case of hydrocephalus is a matter of some anxiety. Spontaneous delivery is not to be anticipated, even in cases of moderate size, except where the fœtus is macerated. Some method of reducing the size of the head is almost always indicated. The chances of survival of a hydrocephalic child are so precarious that we are not justified in incurring the least unnecessary maternal risk in delivery. Consequently when the head presents, the diagnosis having been confirmed by bi-manual examination under anæsthesia, the head should be perforated, through a suture or a fontanelle. This procedure is simple and easy. If, however, labour has been in progress for some hours and the signs of overstretching of the lower uterine segment are recognised (see p. 424), the extraction of the fœtus requires great care. Often the head can be extracted by direct traction exerted by a finger passed into the skull through the perforation aperture and aided by pressure from above on the fundus (Birnbaum). This is preferable to the use of the cranioclast or cephalotribe for traction, as owing to the softness of the cranial structures a good hold cannot be obtained and the blades are therefore liable to slip. After reducing the size of the head version may be performed, but this should not be attempted until after perforation ; the after-coming head can then be extracted with comparative ease. When the fœtus presents by the breech the condition of the head is usually unrecognised until the trunk has been born. Perforation through the tabular occipital bone is easy as a rule. If owing to the presence of pelvic contraction the head is too high to be easily reached with the perforator, it is safer to divide the vertebral column in the upper dorsal region, and pass a catheter up the vertebral canal into the skull, when sufficient fluid may be withdrawn to allow of the delivery of the head by gentle traction.

Gigantism, and in some cases enlargement of the trunk from *general fœtal œdema*, may lead to great difficulty in delivering the *trunk*. In head presentations the greatest obstacle to be overcome is the breadth of the shoulders (bis-acromial diameter).

This prevents trunk rotation, and thus adds to the difficulty. The bis-acromial diameter can, however, be effectually reduced by division of the clavicles (see p. 672), and as the fœtus is in all such cases dead, there is no objection to this procedure. The trunk can then be delivered by steady traction applied to the axillæ, aided by pressure from above. When the breech presents in such cases, the arms invariably become extended and the difficulty of delivery is also very great. Destructive operations are inevitable, and evisceration of the thorax and abdomen is the best procedure; it will then be possible to reach the arms to deliver them in the usual manner. It may, however, also be necessary to perforate the after-coming head, and in order to minimise the risks of injury to the maternal passages, this should be done in preference to a difficult extraction by some other method.

Fig. 272.—Fœtal Ascites. (Ribemont-Dessaignes and Lepage.)

Fœtal Abdominal Enlargement.—The commonest cause of congenital enlargement of the abdomen is *ascites* (Fig. 272); rarer causes are over-distension of the *bladder* from urethral stenosis, and *cystic tumours* of the *kidney* or the *ovary*. An enlarged abdomen may cause insuperable obstruction to the delivery of the trunk; the presenting part—head or breech—is small, and the condition will therefore as a rule be overlooked, until the process of expulsion becomes arrested. Diagnosis can be established by passing the fingers into the vagina under anæsthesia, and carefully estimating the size and outline of the retained trunk. The treatment is, in the case of fluid swellings, to tap the abdomen, and under all other conditions to eviscerate.

Double Monsters.—These are twin fœtuses developed from a single ovum, and organically united by their trunks; some vital organ, such as the liver, the heart, or one of the great arteries, is always common to the two. The differential diagnosis from locked twins may be very difficult during labour. Being

usually small, they do not cause such serious obstruction as would be supposed, and spontaneous delivery may sometimes occur. Decapitation or evisceration may be necessary if the fœtuses are of average size.

Clinical Results of Obstruction.—Not all of the conditions mentioned above invariably give rise to an obstructed labour. The course of labour is greatly influenced by two other factors in addition to the presence of some cause of obstruction : these are (*a*) the size of the fœtus ; (*b*) the strength of the uterine contractions. Thus, many of the fœtal conditions just enumerated will not cause insuperable obstruction if the fœtus is of small size : *e.g.*, transverse presentation and locked twins. And, further, a degree of obstruction which would be insuperable to a feeble uterus may be overcome when the uterus contracts powerfully. The influence of the uterine contractions is especially important in the case of vertex presentations in a contracted pelvis, for the moulding of the head necessary for its passage through the pelvis will not occur unless the uterus acts powerfully. Accordingly a multipara with slight pelvic contraction, who has been delivered either spontaneously or with the aid of forceps in her early labours, may suffer from insuperable obstruction in the later ones, owing to the enfeeblement of the uterus.

The results of obstruction to labour are extremely serious, unless the condition is recognised and appropriately treated early in labour. If exhaustion of the uterus (secondary inertia) occurs, danger is postponed, at any rate for a time. Sometimes tonic contraction will come on, and may lead to the death of the undelivered patient from exhaustion. More frequently obstruction leads to over-distension of the lower uterine segment, and rupture of the uterus or of the uterus and vagina.

Exhaustion from obstructed labour is characterised by local signs of tonic uterine contraction, rise of temperature, rapidity of pulse and respiration, dry tongue, œdema and arrest of secretion of the walls of the vagina and vulva, and finally delirium or convulsions terminating in death. The signs of *over stretching* of the lower uterine segment will be described in connection with the mechanism of uterine rupture.

Diagnosis.—Most of the conditions liable to cause serious obstruction in labour are capable of recognition by careful and systematic examination during the later weeks of pregnancy. Exceptions to this statement are brow presentations, locked twins, and fœtal abdominal enlargements ; the maternal causes are all discoverable before labour. When an ante-partum diagnosis has been made, suitable measures may be adopted in advance for the safe delivery of the patient, and the importance of prophylaxis in these cases cannot be over-estimated. When the diagnosis is not made until labour has begun, the conditions

are of course less favourable, and the longer labour has been in progress before the obstruction is discovered the graver is the prognosis.

There are certain conditions which should at once arouse the suspicion of some cause of obstruction in labour ; thus if the mother shows obvious bony deformity or is stunted in stature ; if the presentation cannot be made out owing to the presenting part being unusually high ; if notwithstanding good uterine pains the presenting part does not come down after the membranes have ruptured ; if the vaginal walls become swollen from œdema, or the presenting parts obscured by a large caput ; or if a swelling is found in the pelvis below the presenting part. In each of these conditions serious obstruction may be present. Careful examination under anæsthesia, including an accurate measurement of the diagonal conjugate and an estimation of the proportion between the head and the pelvis must be made in all such cases.

(V.) MATERNAL INJURIES IN PARTURITION

Rupture of the Uterus

Rupture of the uterus is the most serious accident which can occur in labour. It may take place under varying conditions, and two distinct varieties must be recognised—viz., *traumatic* rupture and *spontaneous* rupture. *Traumatic rupture* is met with in very rare instances in *pregnancy* from direct violence, such as a fall, or a blow or kick upon the abdomen ; more commonly it occurs during *labour*, and is due to intra-uterine manipulations such as version, artificial dilatation of the cervix, destructive operations (fœtal), or forceps extraction, performed either unskilfully or under unfavourable conditions. *Spontaneous rupture* is almost unknown except during labour, and may be due to three different conditions. (*a*) It may be due to overstretching of the lower uterine segment from insuperable obstruction. (*b*) It may be due to uterine defects such as malpositions (*e.g.*, pendulous belly and anteversion from ventrofixation), weakening of the uterine wall by cicatrices of previous Cæsarean section, congenital malformations such as bicornute uterus, etc. (*c*) In very rare instances it occurs during normal labour, or sometimes even during pregnancy, with an apparently healthy uterus ; the explanation of the accident under these circumstances is obscure, but isolated cases have been reported in which cloudy or fatty degeneration of the uterine muscle has been subsequently demonstrated.

Multiparity must be recognised as a powerful predisposing cause of both varieties, for in 94 per cent. of cases the victims

of this accident are multiparæ. This is explained partly by the weakening of the uterine wall which results from frequent childbearing, and partly from the increased frequency of such

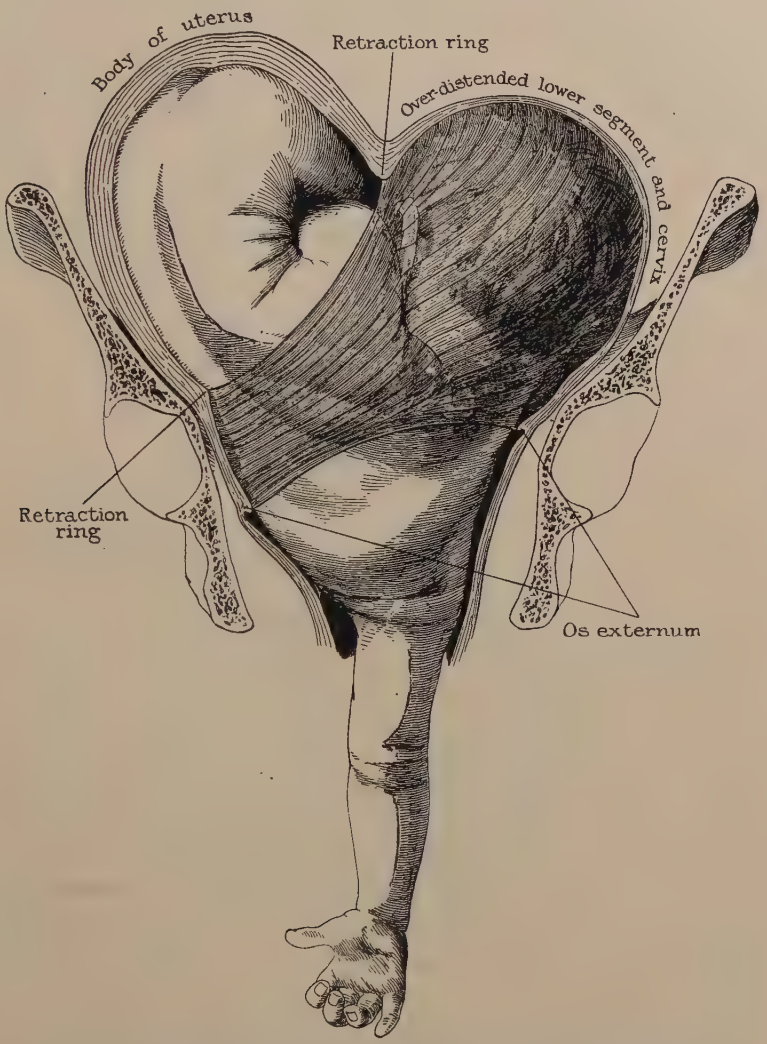


FIG. 273.—Over-distension of the Lower Uterine Segment in Transverse Presentation. (Bumm.)

causes of obstruction as mal-presentations. The frequency of occurrence of rupture of the uterus is estimated at about 1 in 3,000 labours.

Mechanism of Rupture.—(1) *Overstretching of the lower*

uterine segment (*excessive uterine retraction*).—This is the essential cause of spontaneous rupture in all cases due to obstruction. It has been already explained that in normal labour the uterine wall becomes differentiated into an upper active part which retracts as labour proceeds, and a lower passive part which becomes dilated and stretched; separating the two is a well-defined ridge, called the retraction ring, or the ring of Bandl (see p. 243). Sometimes in normal labour this ring can be palpated by abdominal examination in the form of a shallow groove above the level of the pubes. In an obstructed labour—*e.g.*, an uncorrected transverse presentation—these changes in the uterus become greatly exaggerated; retraction proceeds to an extreme degree in the active portion, while stretching becomes correspondingly extreme in the passive portion, which is now made to accommodate the greater part of the body of the fœtus (Figs. 229 and 273). In consequence, the ring of Bandl rises up to, or even above, the level of the umbilicus, and usually runs obliquely across the uterus. The wall of the distended lower segment is greatly thinned, especially in the position occupied by the head, and tightly stretched over the body of the fœtus; it is in imminent danger of giving way before the continued activity of the upper part of the uterus. Accordingly, rupture produced in this manner always begins in the lower segment, but may extend upwards into the body or downwards into the cervix and vagina.

Overstretching and distension of the lower segment may be clinically recognised in the following manner: On examination of the abdomen the uterus will be found to be hard and tender; the outlines of the fœtus will be obscure and its mobility limited; the fœtal heart is probably inaudible; the ring of Bandl will be recognisable as an oblique or transverse groove at about the level of the umbilicus; and one or both round ligaments, tightly stretched over the distended lower segment, may also be felt crossing obliquely the front of the uterus in a direction downwards and outwards towards the middle of Poupart's ligament. It will be remembered that the round ligaments become considerably hypertrophied during pregnancy. On vaginal examination the conditions found will closely resemble those characteristic of tonic contraction. From the latter condition over-distension of the lower segment can best be distinguished by the position of the retraction ring.

(2) *Intra-uterine Manipulations.*—Such procedures as those named above may, from want of skill or care, cause rupture of the uterus when there is no abnormality in labour; they are, however, much more likely to cause this accident when carried out under unsuitable conditions, such as complete escape of liquor amnii, tonic contraction, or over-distension of the lower uterine segment. Under these circumstances the introduction

into the uterus of the hand, or even of a small instrument such as a decapitation hook, is very likely to cause the uterine wall suddenly to give way. Cases of this kind must be regarded as instances of traumatic rupture, for although the condition of the uterus is a powerful predisposing cause, rupture is not spon-

FIG. 274.—Rupture of the Uterus through a Cæsarean Section Scar. (Cameron.)

taneous. Further, methods of rapidly dilating the cervix in labour are always attended by risks of rupture of the cervix and lower segment, for proper regulation of the amount of force employed is very difficult. Again, the extraction of the head by forceps through an imperfectly dilated cervix may cause a deep cervical tear, which, if much force is employed, may spread upwards into the lower uterine segment, and according

to its situation may lay open either the peritoneal cavity, the broad ligament or the bladder. These tears necessarily extend deeply into the vaginal vault as well.

In most cases due to intra-uterine manipulations the rupture starts in the cervix or lower uterine segment; thence it runs up into the body and usually follows the lateral uterine wall, opening up the broad ligament. The majority of such cases are therefore cases of incomplete rupture. Extensive lacerations may, however, open the peritoneal cavity at once, and numerous cases have been recorded in which a tear has been produced in this way, extending from the fundus above, through the uterine body, lower segment, and cervix, into the lateral vaginal wall. In all such cases, where considerable force has been employed to effect delivery, the vulva and perineum are also usually found extensively bruised and lacerated.

(3) *Abnormalities of the Uterus.*—Certain abnormal conditions of the uterus may be the cause of spontaneous rupture or may predispose to traumatic rupture. They may be enumerated as follows:

(*a*) Cicatrices of previous Cæsarean section.
(*b*) Fatty or cloudy degeneration of the uterine muscle.
(*c*) Bicornute uterus (rarely).
(*d*) Uterine tumours (carcinoma of cervix).
(*e*) Misdirection of the uterine axis.

Rupture through a Cæsarean section scar is usually longitudinal and situated in the anterior wall near the mid-line (Figs. 274 and 381). Conditions (*a*) and (*b*) may explain the very rare cases already alluded to in which spontaneous rupture of the uterus occurs in pregnancy or in unobstructed labour. Disease of the uterine muscle can only be recognised by microscopic examination of the organ after its removal from the body. When pregnancy occurs in one horn of a bicornute uterus, the non-gravid horn may be found during labour to occupy a position in which it obstructs the passage of the fœtus through the pelvis, and may then lead to rupture from overstretching of the lower uterine segment. It is extremely rare for uterine tumours to cause rupture.

Misdirection of the Uterine Axis is the chief cause of rupture in cases of 'pendulous belly' (Fig. 64); in this condition the axis of the uterus is directed against the posterior wall of the lower uterine segment, and if the displacement is not corrected during labour the presenting part may be driven through the uterine wall at this spot. Extreme lateral obliquity may similarly predispose to rupture. Cases of spontaneous rupture may be also due to previous operations in which unsuitable methods have been employed for fixing the body of the uterus to the anterior abdominal wall or the anterior vaginal wall. During pregnancy the development of the attached part of the

uterus may then be greatly retarded, the uterus growing, in point of fact, almost entirely at the expense of its posterior wall, which is consequently very much thinner and weaker than normal at term. There is also marked backward and upward displacement of the cervix, in consequence of which the normal mechanism of parturition is greatly modified.

Morbid Anatomy.—Rupture of the uterus is said to be *complete* when all the coats including the peritoneum are torn, and *incomplete* when this is not the case. Rupture of the lateral wall of the uterus, which in pregnancy is uncovered by peritoneum (see p. 60), may include the whole thickness of the muscular wall and still be incomplete, as it merely opens up the

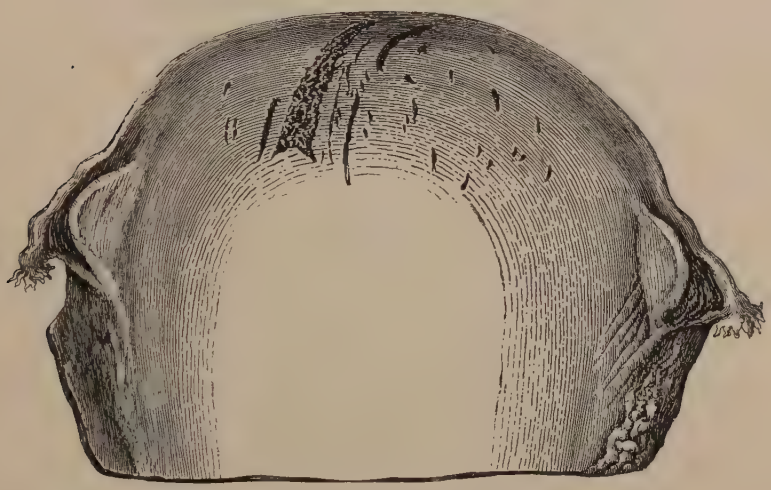


FIG. 275.—Incomplete Uterine Rupture involving the Peritoneal Coat only. (Von Winckel.)

broad ligament, but does not tear the peritoneum. Further, an incomplete rupture opening up the broad ligament may subsequently become complete by the peritoneal layer yielding either from the pressure of accumulated blood, from a portion of the body of the fœtus being driven through it by uterine retraction, or from manipulation of the torn parts. Incomplete rupture sometimes affects chiefly the peritoneal coat, occurring in the form of superficial lacerations which gape and may bleed freely (Fig. 275) ; this is often seen in well-marked cases of over-distension from concealed accidental hæmorrhage.

Cases of spontaneous rupture are more often complete than incomplete ; cases of traumatic rupture are more often incomplete than complete. In the great majority of cases rupture begins in the lower uterine segment, the reason being that

this part of the wall is thinnest and is also most liable to over-distension. The rupture may be confined to the lower segment (Fig. 276), or may extend upwards into the uterine body, even to the fundus, or downwards into the vaginal fornices ; tears

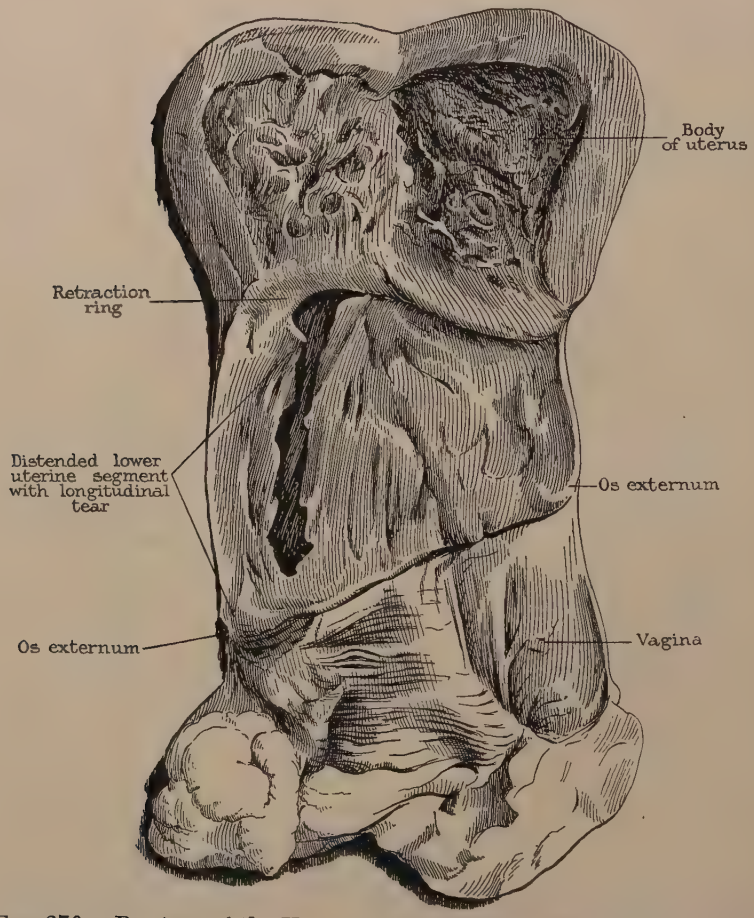


FIG. 276.—Rupture of the Uterus limited to the Lower Segment, which is greatly distended ; the Distension is greater on one side than the other. (Bumm.)

of the anterior wall occasionally extend into the bladder. The *direction* of the tear is in the majority of cases oblique ; occasionally it may be transverse, and sometimes a transverse tear encircles nearly the whole lower segment, almost cutting the uterus in two ; occasionally it is vertical, such tears occurring most frequently on the lateral wall of the uterus (Fig. 277). In

rare instances transverse rupture starts in, and is limited to, the fundus (Fig. 278). Fundal rupture in most recorded instances has been attributed to abnormal thinning of the placental site ; it may, however, occur through the cicatrix of a previous Cæsarean section. Sometimes rupture causes laceration of a large branch of the uterine or vaginal artery, or

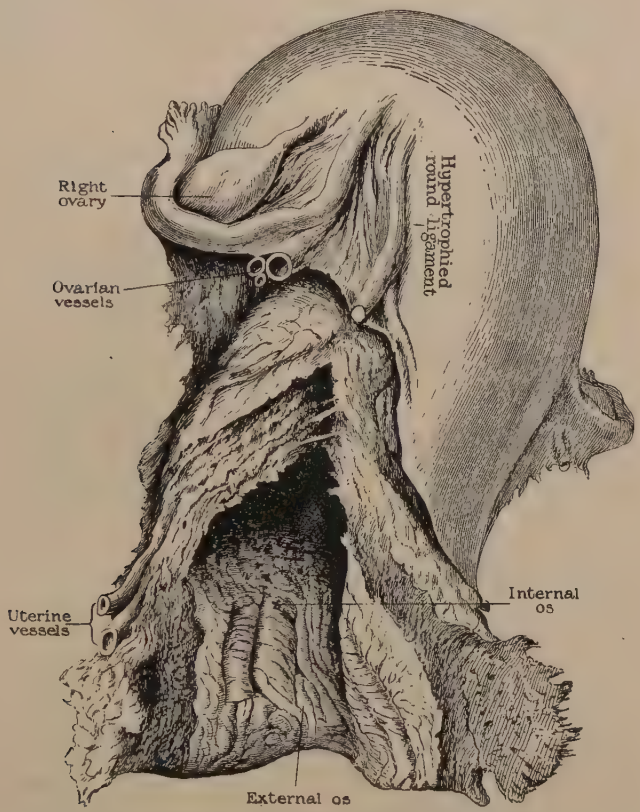


FIG. 277.—Rupture of the Lateral Wall of the Uterus through Lower Segment and Cervix. (Edgar.)

of large uterine veins (Fig. 277) ; serious hæmorrhage then occurs ; this is, however, by no means the rule, and if the large vessels escape, the amount of hæmorrhage may be trifling. Complete rupture of considerable extent is usually followed by the escape of the uterine contents (fœtus or placenta, or both) into the peritoneal cavity ; the empty uterus then retracts firmly and severe hæmorrhage will be impossible, unless large vessels have been torn. When the rupture is small or incom-

plete the fœtus remains in the uterine cavity. Sometimes a part only of the fœtus—the head or a limb—escapes through the rupture, the remainder being retained in the uterus; firm retraction of the edges of the rent upon the extruded part may then occur, preventing the withdrawal of the fœtus through the vagina.

Diagnosis.—In order to establish the diagnosis of rupture of the uterus, it is usually necessary to recognise the laceration by touch. The symptoms which attend this grave accident are

FIG. 278.—Complete Transverse Rupture of the Fundus Uteri. (Von Winckel.)

not always characteristic, although they may arouse the suspicion that rupture has occurred.

Premonitory symptoms of rupture are sometimes described; these are, in point of fact, a history of a long and difficult labour leading up to the symptoms already mentioned as those of tonic contraction and overstretching of the lower uterine segment (p. 411). But it must be borne in mind that although in the majority of cases a long, difficult, and painful labour precedes rupture, this is not always the case, for spontaneous rupture may occur early in normal labour.

The *attendant symptoms* are probably influenced mainly by

the rapidity with which the laceration is produced, and the amount of hæmorrhage which accompanies it. Sudden rupture is attended by severe shock and acute abdominal pain, sometimes also by the sensation that something has burst and by the sudden cessation of the pains, which have been, in most cases, unusually severe. There may be some external bleeding, but this is seldom, if ever, profuse ; the greater part of the effused blood is retained when, if a large vessel has been torn, signs of more or less severe internal hæmorrhage gradually manifest themselves. Occasionally internal hæmorrhage may be so profuse as to cause death in an hour or two. Incomplete rupture produces much less severe symptoms, and less profuse hæmorrhage, than complete rupture. It may accordingly be said that the chief symptoms pointing to the occurrence of rupture are the sudden or rapid development of symptoms of shock—*e.g.*, pallor, cold clammy skin and rapid pulse, in a case in which labour has been long, or artificial delivery has been accomplished with difficulty. When also there is external bleeding, and though delivery has not taken place the pains suddenly cease, the presumption is greatly strengthened.

Abdominal examination yields no certain information unless the fœtus has escaped from the uterus, when the physical signs are striking. The fœtal parts can be palpated with great ease through the abdominal wall ; there is also extreme mobility both of the limbs and of the whole body. In the lower abdomen the hard retracted uterus will be found of the size natural to the termination of the third stage of labour, and quite separate from the fœtus. If the fœtus remains in the uterus after rupture has occurred, it is seldom possible to make the diagnosis until after delivery. Incomplete rupture through the anterior or lateral wall of the lower uterine segment may result in the formation of an extensive retroperitoneal hæmatoma which can sometimes be palpated as a diffuse fluctuant swelling over the anterior or antero-lateral aspect of the lower segment.

Whenever it is suspected before delivery that rupture has occurred, a careful examination under anæsthesia should be made, the whole hand being passed into the vagina for this purpose, as it is obviously necessary to reach the lower uterine segment. If the laceration has extended into the vaginal vault, its lower end will be easily found ; the full extent of the injury is often difficult to estimate until the uterus is empty.

In many cases, however, the suspicion of rupture does not arise until after the delivery of the patient, either with or without artificial aid. The bad general condition of the patient then attracts attention, and definite symptoms of severe shock supervene. If the placenta has escaped through the rent into the peritoneal cavity, attempts to deliver it in the ordinary way will be unsuccessful ; in some cases considerable external

bleeding occurs although the placenta has been delivered and the uterus is firmly retracted ; or the patient may show immediate signs of collapse ; but in some cases suspicion of rupture has not been aroused for several hours after the termination of labour, owing to the gradual development of the symptoms. Under all such circumstances as these, careful search should be made for a rupture. If the placenta has escaped through the rent into the peritoneal cavity, the cord will guide the fingers up to and through the rent. Occasionally a coil of small intestine may protrude through the rupture into the vagina. It is a point of practical importance to decide whether the rupture is complete or incomplete, for treatment depends upon this point to some extent. If a coil of intestine has prolasped, or if the finger passed through the tear definitely detects bowel or any other organ, such as the omentum or the ovary, it is certain that the rupture is complete. In incomplete rupture opening up the broad ligament extensively, a thin layer of peritoneum and cellular tissue intervenes between the viscera and the finger, and prolapse of gut cannot occur.

Risks.—Rupture of the uterus during labour is one of the most serious accidents which can befall a parturient woman. The mortality has been estimated by various authorities at from 70 to 80 per cent. ; for cases treated under favourable conditions, such as are offered by Maternity Hospitals, it is probably, under modern methods, not more than 50 to 60 per cent. (Munro Kerr). But even this modified rate is extremely high. The *immediate* risks are shock and hæmorrhage ; if the patient survives these she has still to encounter the more *remote* risks of septic infection. Shock and hæmorrhage occur together, and the influence of the two in determining a fatal result cannot be separately estimated ; deaths occurring within twenty-four hours of delivery are practically all due to these causes. Probably 50 per cent. *of the mortality* is the result of combined shock and hæmorrhage, the remaining 50 per cent. being due to sepsis. The frequent occurrence of septic infection is to be explained by two considerations. Firstly, rupture of the uterus is as a rule the direct outcome of bad obstetrics, as in the case of failure to recognise a transverse presentation, or of untimely or unskilful operative interference. Consequently it is among the poorest classes that cases of rupture usually occur, and in these patients insanitary surroundings, want of personal cleanliness, and absence of trained nursing attendance, all favour the occurrence of sepsis. When a woman suffering from this injury is brought to hospital for treatment she has in many cases been already infected. Secondly, even if skilled attendance in labour has been available, the existence of an extensive internal laceration throwing the vaginal canal into direct communication with the peritoneal cavity or the pelvic cellular tissue,

offers unusual facilities for the spread of any infective agent which may gain admission.

Treatment.—This must be considered from two points of view : (1) how to deliver the patient ; (2) how to deal with the rupture.

(1) If it is believed, after careful examination, that the fœtus is still in the uterine cavity, an attempt may be made to deliver it through the natural passages ; causes of obstruction must be carefully looked for and estimated, and suitable methods of extraction then adopted. If the presentation is an impacted shoulder no attempt at version should be made ; but the child may be delivered by decapitation, or by some method of embryotomy if the neck is difficult to reach (see p. 670). Intra-uterine manipulations under these circumstances are certain greatly to increase the tear if it has already occurred. Many obstetric surgeons hold the view that the fœtus should never be delivered through the natural passages, whatever be the nature of the tear or the extent of the hæmorrhage ; they believe that the best results will follow laparotomy in all cases. If a part of the fœtus has escaped through the rent, laparotomy is certainly the best procedure, and if the fœtus has been expelled completely into the peritoneal cavity, laparotomy is the only possible method of delivery. If the child is born, but the placenta has escaped from the uterus, laparotomy should be performed ; this is safer than delivering the placenta by traction on the cord or by manual removal through the rent, because of the dangers of extending the tear and of increasing the hæmorrhage.

(2) The *treatment* of the *rupture* is in all cases a matter of difficulty, and great differences of opinion have been expressed as to the best method of dealing with it. Upon one point there is agreement, viz., that the immediate indications are to ascertain the full extent of the injury, and to adopt energetic measures to diminish shock. The entire hand should be passed into the vagina immediately after delivery, so that the position and size of the laceration may be clearly determined. Special attention should be paid to two points—whether the tear has opened the peritoneal cavity or has injured the bladder. The amount of external bleeding is usually slight, but the uterine cavity should be freely irrigated with normal saline solution, and the vaginal walls thoroughly irrigated and swabbed with lysol solution, a teaspoonful to a pint. When the general condition of the patient is grave, and there is severe shock, nothing further should be done until certain restorative measures have been adopted.

The essential feature of shock is profound depression of the circulation, indicated by a small, soft and rapid pulse, coldness and pallor of the skin, with slight cyanosis of the lips. The temperature is sub-normal, the respiration shallow but not

greatly quickened, the mental condition lethargic; or there may be loss of consciousness. The reaction is indicated first by improvement in the pulse, and then by a return of warmth to the body surface. When there is severe shock the patient should be kept recumbent with the foot of the bed raised; if it is desired to move her into hospital this should be postponed until some degree of reaction has been obtained. The two chief requirements in the treatment of shock are the application of warmth to the body, and the rapid introduction of fluid into the circulation. Intravenous saline infusion or blood transfusion should be postponed until after the source of hæmorrhage has been controlled by operation or plugging.

The treatment of the injury itself may be either expectant or operative. *Expectant* treatment consists in establishing free vaginal drainage from the lacerated parts, combined with plugging of rents or of cavities with gauze, if required for the control of oozing or of more active hæmorrhage, and the administration of pituitary extract. Probably a better method is to drain by means of large rubber tubes, which must be stitched in position and made to pass deeply above the level of the lacerations. Thus the tubes may pass into the peritoneal cavity, or into the widely opened pelvic cellular tissue in cases of incomplete rutpure opening up the broad ligament. In all cases where the surroundings of the patient are unfavourable for the performance of a serious surgical operation the expectant method should be adopted. In cases of incomplete rupture it may be possible by making traction on the uterus to pull it down to the vulva sufficiently to allow of the laceration in the uterine wall being directly closed with stitches. The broad ligament cavity then remains in communication with the vagina only; it should not be closed, but plugged with a strip of gauze or drained with a rubber tube. *Operative* treatment of complete rupture consists in opening the abdomen, and after carefully investigating the position and extent of the injuries, either removing the ruptured uterus by hysterectomy, or sewing up the lacerations. If the patient survives the operation of hysterectomy the risk of sepsis has been almost eliminated. When rupture has been followed by escape of the fœtus into the peritoneal cavity an abdominal operation must in all cases be performed in order to deliver the fœtus, and this allows of the rupture being at the same time dealt with.

The advantage of the operative treatment is that the full extent of the injury can be discovered, hæmorrhage completely arrested, bruised or possibly infected tissues or organs removed, the peritoneal cavity cleansed, and free drainage provided both by the supra-pubic and vaginal routes. When the laceration is not very extensive, and is situated in an accessible position, it may be stitched up and the uterus saved. But experience

shows that a high mortality from sepsis attends this procedure, for if the uterus is infected the edges of the tear will not unite, and septic peritonitis then ensues. The great disadvantage of both forms of abdominal operation is that the patient's general condition is often so bad that the performance of an extensive operation such as these appears to be almost a forlorn hope. On the other hand the expectant method, if at first successful, is attended by grave risks of sepsis in convalescence, for the uterus itself may have been infected during labour, and, further, by this method the peritoneal cavity cannot be thoroughly cleansed. And again, concealed hæmorrhage may continue from some deeply-placed vessel.

The most efficient method is undoubtedly to operate and remove the uterus by hysterectomy ; thus bleeding is finally controlled and the risks of sepsis avoided as far as may be. But by many obstetricians the severe shock attending rupture of the uterus is held of itself to contra-indicate such a severe operation as this. Recent statistics, however, appear to show that a larger percentage of recoveries attends hysterectomy than any other method, whether operative or expectant, of dealing with bad cases of rupture of the uterus. It is probable that in time this method will be generally accepted for such cases, the expectant method being reserved for those in which the injury is comparatively slight.

Lacerations of the cervix and vagina frequently occur in labour and are of minor importance. A certain amount of laceration of the cervix is usual in a primipara and requires no treatment ; it is usually longitudinal in direction and lateral in position, being much more frequent upon the left than the right side. This is explained by the predominant frequency of the first vertex position, in which the broad end of the head distends the left side of the cervix. Sometimes these lacerations are more extensive and run up to the vaginal roof, or open the base of the broad ligament ; they should then be treated by douching the ragged cavity formed by the tear, and draining it with a large rubber tube. Occasionally transverse rupture of the anterior lip occurs from non-dilatation of the external os, and delivery takes place through the rent which is situated in front of the undilated os (Fig. 268). In extensive rupture of the lower uterine segment the laceration frequently extends into the cervix and upper part of the vaginal wall.

In severe laceration of the pelvic floor the lower third of the posterior vaginal wall of necessity participates. Vaginal lacerations are thus most frequent in the upper and lower thirds. They may also occur in the middle third in obstructed labour or difficult instrumental delivery ; if upon the anterior wall, the base of the bladder may then be lacerated, giving rise to a vesico-vaginal fistula. Sometimes, from prolonged compres-

sion between the fœtal head and the pelvic bones, an area of the anterior vaginal wall is damaged beyond recovery, and sloughing occurs. The slough then separates during the first week of the puerperium, and may open the base of the bladder, resulting in a vesico-vaginal fistula. When an extensive area in any position has sloughed, the process of cicatrisation is attended by well-marked constriction, and may result in vaginal atresia of extreme degree. Lacerations of the cervix and vaginal roof do not require suture unless there is hæmorrhage ; those of the lower third of the vagina should always be repaired at the same time as the injury to the perineum.

Rupture of Veins (*Vaginal and vulval hæmatoma*).—Large effusions of blood from ruptured veins may form beneath the vaginal walls during labour. The cause of rupture of the vaginal veins is not well known, but the accident occurs chiefly in prolonged labour or operative delivery. It may be also met with in pregnancy as the result of direct injury. The formation of the hæmatoma begins beneath one of the lateral vaginal walls, and usually extends downwards into the labium majus, forming a characteristic vulval swelling which may attain considerable size. Sometimes the tumour does not extend to the vulva, and then it can be recognised only by vaginal examination. The vulval swelling presents distinctive characters ; it is soft and fluctuating, of a deep violet colour where covered with mucous membrane, and is associated with subcutaneous ecchymosis, extending over the perineum, around the anus, and upon the inner aspect of the thighs.

A vaginal hæmatoma may form during the second stage of labour, and cause obstruction to delivery ; usually, however, it appears during or soon after the third stage. It is associated with severe pain, and the loss of blood from the general circulation may be sufficient to produce urgent symptoms of internal hæmorrhage. Occasionally spontaneous rupture of the hæmatoma occurs, leading to the escape of a large quantity of fluid and clotted blood.

The *treatment* is expectant, with strict antiseptic management of the puerperium. If the thrombus should become infected, it must be laid freely open, the cavity cleared out, douched, and packed with gauze.

Pelvic Hæmatoma.—The occurrence of hæmorrhage between the layers of the broad ligament in incomplete rupture of the uterus has been already referred to ; this condition is called a pelvic hæmatoma. Rare cases have been reported in which the same condition has occurred without injury to the uterus, the source of the bleeding being ruptured veins in the connective tissue of the base of the broad ligament. Such hæmorrhages may be very extensive, dissecting up the whole of the pelvic peritoneum, passing on to the abdominal parietes and into the

iliac fossæ, and giving rise to the symptoms of severe internal hæmorrhage. Small effusions which give rise to no urgent symptoms require no operative treatment; but if there is a large subperitoneal hæmatoma, accompanied by progressive symptoms of internal hæmorrhage, the abdomen should be opened, the blood clots evacuated, and the bleeding controlled by ligature or by packing the cavity with gauze.

Rupture of the Perineum.—This minor accident is of frequent occurrence, but usually of small importance. It is only referred to here in order to emphasise again the importance of examining the perineum in every case after delivery, and of immediately repairing all lacerations which include more than the skin of the fourchette. Lacerations involving the sphincter ani are of great importance, because, unless successfully repaired, troublesome rectal incontinence will ensue. The chief varieties of perineal rupture, along with the suitable methods of repair, are described on p. 677.

Inversion of the Uterus

This condition is a turning inside out of the uterus. It is one of the rarest complications of labour, being only met with in from 1 in 180,000 to 1 in 200,000 labours. Three degrees of inversion may be described: in the first the placental site—*i.e.*, the fundus—is depressed so as to bulge to a greater or less extent into the uterine cavity (Fig. 279, *a*); in the second the fundus protrudes through the external os so as to enter the vaginal canal (Fig. 279, *b*); in the third the fundus presents at, or protrudes through, the vulva (Fig. 279, *c*), the inversion being complete. It occurs either during the third stage of labour or immediately afterwards, but it is highly probable that the process always begins during the third stage, although it may not be recognised until later.

Causes.—Inversion may occur *spontaneously*, or may be *induced* by improper methods of delivering the placenta. When *spontaneous* it may be due to precipitate labour, but the usual cause is atony of the wall of the fundus uteri; by straining efforts on the part of the patient the relaxed area is slightly inverted, and the process then proceeds by the active part of the uterus contracting upon the inverted part and driving it onwards towards the cervix. It is also stated that spontaneous inversion may be started during the second stage of labour by traction exerted upon the placental site through a relatively or absolutely short umbilical cord. (The cord is said to be relatively shortened when coiled round the body or limbs of the fœtus.) It is, however, difficult to believe that traction through the cord upon the wall of an actively contracting uterus could cause inversion.

Inversion may be *induced* during the third stage by endeavouring to deliver the placenta by pressure on the fundus or by traction on the cord, when the uterus is relaxed. It is probable that the process is merely started in this way, and is then carried on spontaneously by uterine contractions. Inversion is usually produced rapidly, but sometimes appears to occupy several days for its completion.

Symptoms.—Pain is a constant symptom. In the second and third degrees well-marked symptoms of shock also occur, and the pain becomes expulsive in character. There is usually hæmorrhage, but it is very variable in amount, and seldom profuse. The placenta usually remains attached to the inverted

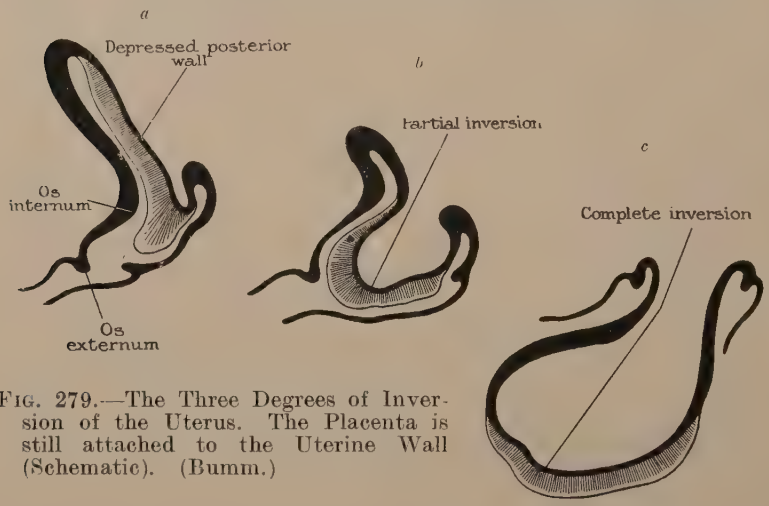


FIG. 279.—The Three Degrees of Inversion of the Uterus. The Placenta is still attached to the Uterine Wall (Schematic). (Bumm.)

fundus ; when the placenta has been detached before inversion the risks of profuse bleeding are much greater.

The *diagnosis* of this accident is not difficult if the patient is seen soon after it has occurred. In the first degree it may be possible to palpate the fundal depression through the lax abdominal walls. When the fundus has been expelled into the vagina, abdominal examination shows that the body of the uterus has disappeared from its normal position, and the ring formed by the neck of the inverted organ may sometimes be felt with the fingers ; on vaginal examination the firm round swelling protruding through the cervix, and usually covered by the placenta, will then be recognised without difficulty as the inverted fundus. Diagnosis in the third degree is a simple matter when the placenta remains attached ; but a number of cases have been recorded in which, the placenta being detached, the inverted uterus has been amputated in the erroneous belief

that it was a fibroid polypus. Attention to the abdominal examination showing that the uterus is not to be felt there after labour should prevent this mistake.

The *prognosis* is grave ; death may occur from hæmorrhage or from shock, which may even prove fatal after a reduction of the displacement. In some cases, on the other hand, the condition may remain undiscovered, giving rise to no urgent symptoms ; it then passes into the phase of *chronic inversion*, which is dealt with in text-books of gynæcology.

The *treatment* consists in the immediate reduction of the displacement by taxis ; after careful antiseptic preparation, including shaving and freely swabbing the external genitalia with tincture of iodine, the uterus should be reinverted, beginning at the cervix, and gradually returning first the cervical part, and last the fundus. The patient is anæsthetised, and one hand is placed upon the abdomen and two fingers are pressed down into the inversion ring, while the organ is gradually replaced with the fingers of the other hand introduced into the vagina. When the displacement has been completely returned, a hot intra-uterine antiseptic douche should be given, partly for disinfection and partly to promote uterine contraction. The uterus should be continuously massaged and pituitary extract or ergot administered to counteract the tendency which these cases show to inertia, and resulting risk of recurrence of the inversion. In the second and third degrees the placenta should be removed before beginning the replacement, in order to diminish the bulk of the body to be returned through the inversion ring ; this is unnecessary in the first degree. Occasionally the uterus cannot be completely returned by taxis ; hot douches should then be used and continuous pressure applied to the inverted uterus by packing the vagina with sterile gauze under strict antiseptic precautions. After twelve to twenty-four hours of continuous pressure, taxis may then be repeated and will probably prove successful. When twenty-four hours or more have elapsed before the accident is discovered the chances of infection of the placental site having occurred are, of course, very great. It would then be advisable to wait for a few days before again attempting reposition, for the manipulation of the infected uterine wall would obviously be attended by risks of laceration, and of dissemination of the infection. Local disinfection of the placental site is also easier while the inversion is unreduced.

(VI.) ANTE-PARTUM HÆMORRHAGE

By some writers the term " ante-partum hæmorrhage " is used to include all cases of hæmorrhage occurring either in connec-

tion with pregnancy at any period, or in connection with the first and second stages of labour. In this work hæmorrhages occurring before the period of fœtal viability has been reached have been already dealt with as Disorders of Pregnancy ; it is, further, more convenient from a clinical standpoint to restrict the term "ante-partum hæmorrhage" to cases occurring either in pregnancy after the period of viability has been reached, or during labour before the birth of the child. Slight cases of ante-partum hæmorrhage, as thus defined, may be due to such conditions as fibroid tumours or malignant disease of the cervix, and these conditions have been already sufficiently dealt with. Occasionally in the later months of pregnancy profuse hæmorrhage may arise from rupture of a varicose vein in the vaginal wall or in the vulva. These cases are, however, quite exceptional, and as a rule severe hæmorrhage at this period is due to bleeding *from the placental site*, and it is with these cases that this section is solely concerned.

FIG. 280.—Basal Placenta Prævia ; the part of the Placenta which is attached to the Lower Uterine Segment is developed upon the Decidua Basalis. (Webster.)

Cases of ante-partum hæmorrhage, as thus defined (*i.e.*, as bleeding from the placental site during the last three months of pregnancy), are divided into two classes, the basis of classification being the situation of the placenta. In one class the placenta occupies the normal position—*i.e.*, it is implanted upon the uterine wall entirely above the level of the lower uterine segment ; ante-partum hæmorrhage is in this class due to premature separation of the placenta, from local or general disease, or from traumatism. In the other class the placenta occupies some part or the whole of the lower uterine segment ; ante-partum hæmorrhage in these cases will necessarily occur independently of accident or disease, because the changes which normally take place in the lower segment before and during labour inevitably cause the placenta to be detached from it. The former are known as cases of *Accidental Hæmor-*

rhage; the latter as cases of *Placenta Prævia* or *Unavoidable Hæmorrhage*. It must be borne in mind that the essential difference between them is the position of the placenta in the uterus, for traumatism and disease are not limited to the class of so-called accidental hæmorrhage, but are quite as likely to affect an abnormally situated placenta as one normally situated.

Causation.—1. We have first to inquire, what are the causes which lead to the *implantation of the placenta in the lower uterine*

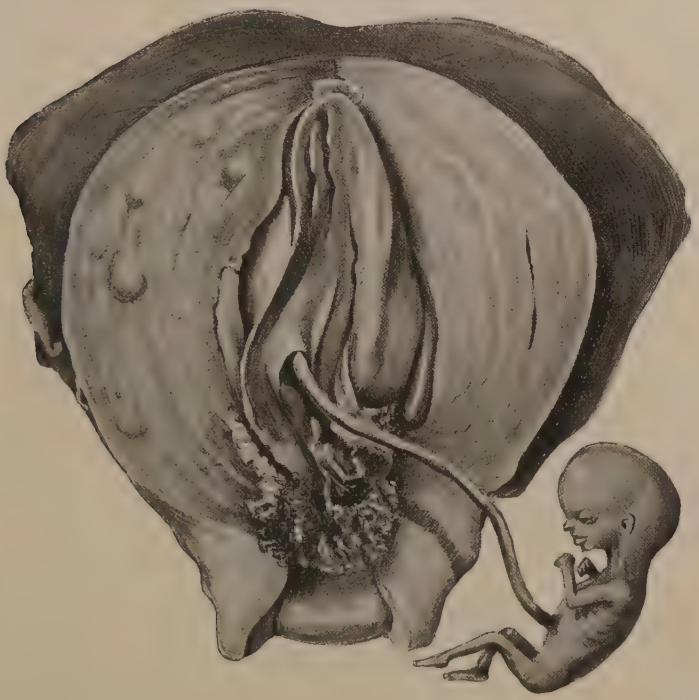


FIG. 281.—A Gravid Uterus with a Fibroid Tumour. The Placenta is situated entirely in the Lower Uterine Segment. (Willey.)

segment? Recent observations have made it clear that there are two different ways in which it may occur : (*a*) the fertilised ovum may become imbedded in the lower part of the uterus when it first enters this organ, instead of, as is usually the case, at the fundus ; this explanation was commonly applied to all cases until a few years ago ; (*b*) after implantation of the ovum in the normal position, the placenta may so develop as to become attached in part to the lower uterine segment. Cases of the first kind are characterised by the formation of the decidua basalis, wholly or partly, upon the part of the mucosa which

covers the lower uterine segment. In cases of the second kind the placenta is developed in whole or in part, in connection with the decidua capsularis ; as the ovum grows large enough to fill the uterine cavity, decidua capsularis and decidua vera fuse, and a part of the placenta thus becomes attached to the uterine wall over the lower segment. The former may be conveniently called *basal placental prævia* and is shown in Figs. 86.

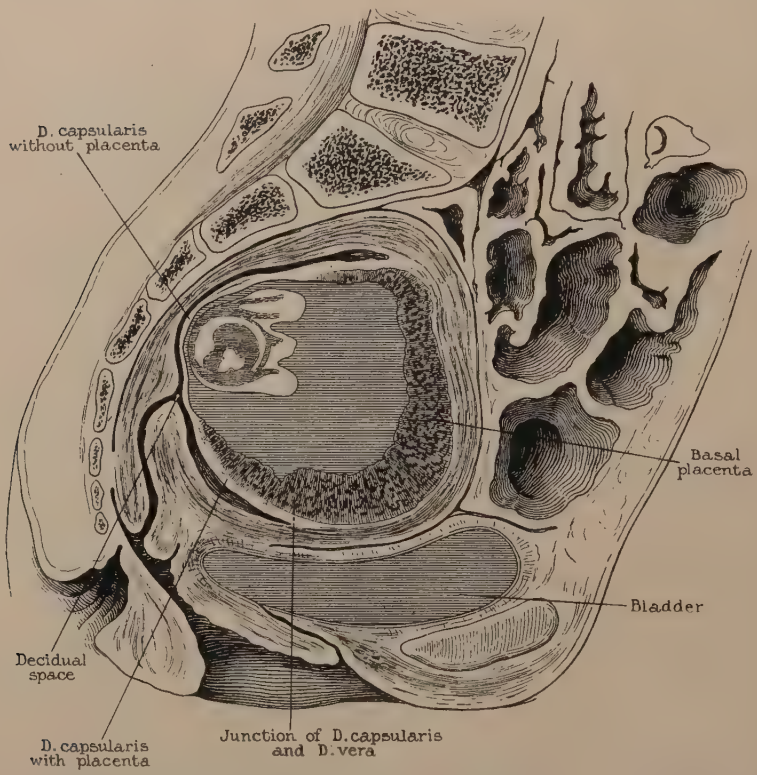


FIG. 282.—Capsular Placenta Prævia, Lateral Variety. From a Frozen Section. (Clarence Webster.)

280 and 281 ; the decidua capsularis can be clearly seen in the upper part of Fig. 280, and it is obvious that the placenta is formed, not upon it, but upon the decidua basalis. The latter may conveniently be called *capsular placenta prævia*, and is shown in Fig. 282 ; here in a three months' ovum it is seen that the decidual space persists and a portion of the placenta has developed upon the decidua capsularis on either side of the decidua basalis. In this specimen Webster described the part of the decidua capsularis upon which placental formation has

occurred as closely resembling in vascularity and general appearance the decidua basalis adjacent to it. At a later stage of pregnancy a portion of the capsular placenta would lie upon the lower segment and cover the internal os. This part of the decidua capsularis probably fuses firmly with the decidua vera, to which it becomes apposed, and vascular connections with the uterine wall are thereby established.

It seems probable that further observation will show that cases of complete placenta prævia are always basal. Cases of partial or marginal placenta prævia may be either basal or capsular; it is possible that some cases are partly basal and partly capsular.

The explanation cannot be carried further than this; we do not know what are the conditions which lead to the formation of a capsular placenta, or to the original implantation of the ovum upon the lower part of the uterine wall instead of near the fundus. Clinical evidence shows that multiparity, especially when associated with rapid child-bearing, is a powerful predisposing cause; there is a certain amount of evidence also that chronic endometritis and fibroid tumours may stand in the same relation (Figs. 86 and 281). It will be observed that each of these three conditions is associated with enlargement of the uterine cavity. Under normal conditions the uterine cavity is potential only; when dilated it is obvious that the fertilised ovum may more readily descend into the lower segment before it becomes embedded. The placenta itself is frequently abnormal; extensive areas of degenerated villi may often be found (*placental infarcts*), and the cord often has a marginal or velamentous insertion. The nutrition and development of the fœtus are unaffected.

Given a low implantation of the placenta it is impossible for labour to take place without hæmorrhage, for when the lower uterine segment dilates and the cervix opens during the first stage, the placenta will inevitably become in part or wholly detached, and bleeding will occur from the lacerated placental vessels in the uterine wall (Fig. 283). Hence this kind of ante-partum hæmorrhage is often named *Unavoidable Hæmorrhage*. But the low position of the placenta is not the only possible cause of hæmorrhage in such cases, for traumatism or local disease, such as will be described in the next paragraph, may affect a placenta prævia, and, by causing partial detachment, may lead to hæmorrhage.

2. With regard to *accidental hæmorrhage*, instances are rare in which it can be attributed solely to direct injury—*e.g.*, a kick on the abdomen or a fall; but there is no doubt that such injuries may cause separation of a healthy placenta from its normal attachments. It has also been suggested that a very short cord may be the cause of hæmorrhage during the second

stage of labour, from traction on the placenta; but of this there is very slender evidence. In nearly all cases the hæmorrhage

FIG. 283.—Frozen Section of a Woman who died of Hæmorrhage due to Placenta Prævia. The cervix is partly dilated, the placenta prævia is lateral, the fœtus presents by the breech. (Barbour's Anatomy of Labour.)

is absolutely spontaneous. Moreover, observations have shown that the majority of cases, amounting to 80 per cent. in the series reported by Gordon Ley, are accompanied by albuminuria

of greater or less degree, and sometimes headache, œdema and a raised blood-pressure are present as in the typical albuminuria of pregnancy. Cases have recently been reported in which eclampsia and accidental hæmorrhage were associated in the same patient. The clinical evidence that accidental hæmorrhage has a toxæmic origin is very strong, and the clinical is further supported by the pathological evidence that in many fatal cases necrotic and hæmorrhagic changes in the liver and kidneys have been found, similar to the well-known changes in eclampsia. The urinary tests are therefore of special importance in these cases, and the presence of albumen may actually be regarded as an important point of differential diagnosis, though not always a reliable one, between accidental hæmorrhage and placenta prævia. Histological examination of the uterine wall after its removal by operation has revealed necrotic areas in the decidua, and herein lies the primary source of the hæmorrhage. The decidual blood-vessels, which are mere channels in the decidua, give way under the combined effect of necrotic changes in their walls and supporting tissues, and the high blood-pressure which almost invariably accompanies these cases; a retro-placental decidual hæmatoma forms (Plate V., 1, p. 157), which may be the starting-point of detachment of the placenta from the uterine wall over a wide area and profuse retro-placental hæmorrhage.

In cases of 'concealed' accidental hæmorrhage interstitial hæmorrhages are often found in the muscular wall, but this is probably the result of the great and sudden over-distension of the organ and is not related to the original hæmorrhage from the placental site.

It must be admitted that accidental hæmorrhage is relatively rare in primigravidæ, who much more commonly suffer from pregnancy toxæmia than multiparæ. Multiparity is a powerful predisposing cause, and the great majority of cases occur in women who are in bad health. It is accordingly much commoner in hospitals than in private practice.

3. The question next arises, why does ante-partum hæmorrhage always occur when the placenta invades the lower uterine segment, and not when it occupies the normal situation? The answer will be found in the different functions of the upper and lower parts of the body of the uterus. The upper part plays an active *rôle* in labour, undergoing intermittent contractions, with progressive and continuous retraction. The attachment of the placenta to this part of the uterine wall is not affected by the normal contractions of the first and second stages, for although these doubtless entail a slight diminution in the superficies of the uterine wall, this diminution is not sufficient to disturb the placental attachments. Retraction causes more extensive reduction of the superficies of the uterine wall, but

until the body of the fœtus has been expelled retraction is only slight in normal labour, and therefore the placenta is able to maintain its attachments. The lower part of the uterus, on the other hand, plays a passive *rôle ;* no contractions occur in it, but it gradually becomes stretched during the stage of dilatation so that its superficial area is greatly increased, and its shape altered from that of a section of a hemisphere to that of a cylinder. The placenta is unable to expand in correspondence with the stretching of its site of attachment, and the consequence is that the uterine wall becomes progressively torn away from the placenta, and hæmorrhage then occurs from lacerated utero-placental vessels. Hæmorrhage is, accordingly, said to be *unavoidable* in placenta prævia.

Fig. 284.—Central Placenta Prævia ; the Placenta occupies the whole of the Lower Uterine Segment. (Bumm.)

But how can we account for the occurrence of bleeding *before* the onset of labour, in cases of placenta prævia ? It is possible that, in a certain proportion, disease of the placenta or traumatism—direct or indirect—may explain it. In many cases, however, the bleeding appears to be due solely to the abnormal situation of the placenta. A *physiological* explanation of these cases has been suggested by Pinard — viz., that during the last few weeks of pregnancy the intermittent uterine contractions become gradually stronger (they are certainly more easily palpable), although they remain painless and unperceived by the mother. Upon the lower segment and cervix these contractions exercise a dilating force, which may be sufficient to cause slight separation of the placenta and more or less profuse hæmorrhage. In support of this explanation may be cited the clinical fact that

a degree of dilatation of the internal os sufficient to admit one finger is met with in the last few weeks of pregnancy, frequently in multiparæ, occasionally in primigravidæ.

Morbid Anatomy.—1. *Placenta prævia.*—The extent of the area which the placenta occupies in the lower segment varies, and three degrees are accordingly distinguished: (1) The

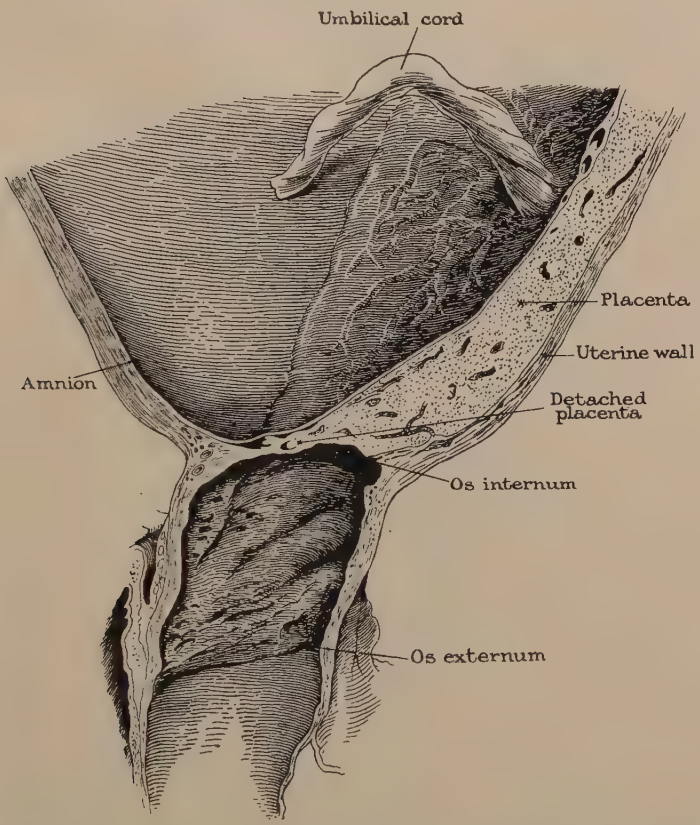


FIG. 285.—Lateral Placenta Prævia. The Placenta overlaps the os internum, which is partly dilated. From a Frozen Section. (Ahlfeld.)

placenta may occupy the whole of the lower segment, its centre being situated approximately over the internal os; this is called *central placenta prævia* (Figs. 281 and 284). In clinical practice, cases are called *central* in which the placenta completely covers the os and the margin cannot be reached by the finger. (2) It may occupy approximately one-half of the ower segment, the placenta covering the undilated internal os; this is

called *lateral placenta prævia* (Figs. 283 and 285). (3) It may be attached only to the upper part of the lower segment on one side, so as to lie completely above the level of the internal os; this is called *marginal placenta prævia* (Fig. 282). It will be obvious that in each variety the placenta to a greater or less extent also overlaps the *safe zone—i.e.*, the uterine wall above the upper limit of the lower segment. The amount of hæmor-

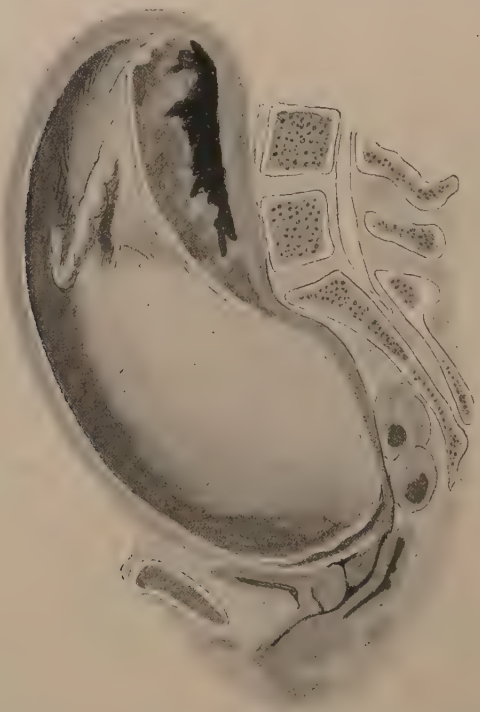


Fig. 286.—Section of Uterus from Patient dying at Eighth Month of Eclampsia. There is a large retro-placental hæmatoma, about half the area of the placenta being separated from its site. Partial separation of the membranes is seen in the lower uterine segment. (Winter.)

rhage met with depends mainly, if not entirely, upon the extent of placental site which is laid bare in the process of dilatation; accordingly there will generally be the greatest amount with *central*, the least with *marginal*, placenta prævia. And, further, inasmuch as the central variety offers a mechanical obstacle both to the expulsion of the fœtus and to the performance of any intra-uterine operation, it is the most difficult to deal with.

From clinical evidence there is reason to believe that the

wall of the lower segment is unusually weak and friable when the placenta is inserted upon it; no abnormal thinning has been detected in frozen sections (Figs. 282 and 283), but the

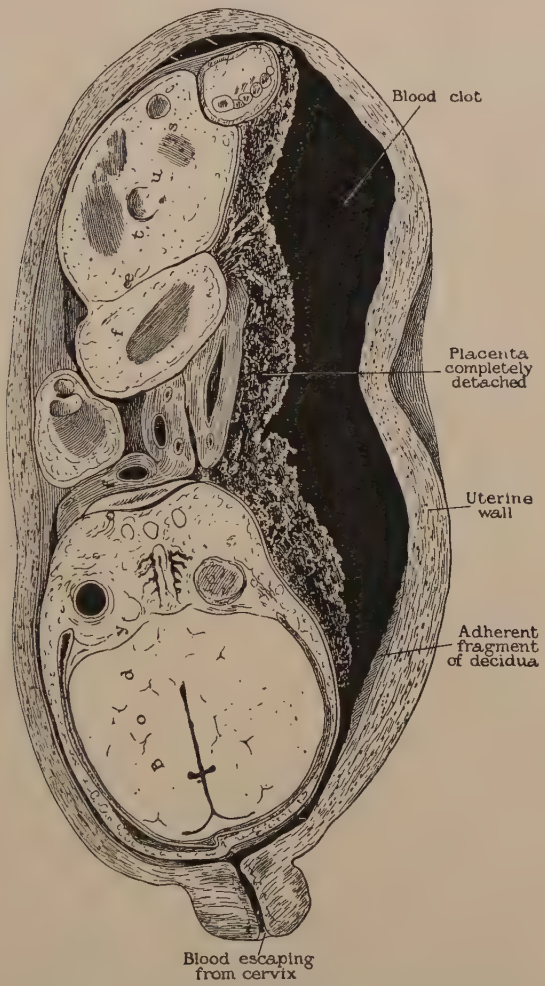


FIG. 287.—Concealed Accidental Hæmorrhage. (Varnier.)

development in it of the large sub-placental venous sinuses probably lessens the resisting power of the uterine wall. The practical result is that rupture of the lower segment is very readily caused by intra-uterine manipulations.

2. *Accidental Hæmorrhage.*—It is rarely the case that the

entire placenta is separated from the uterine wall in accidental hæmorrhage, although this occurrence is shown (from nature) in Fig. 287 ; here a very large effusion was formed behind the placenta, which resulted in the death of the patient from internal hæmorrhage. Separation of a portion only of the placenta is, however, quite enough to cause very severe bleeding. Usually the effused blood escapes under the placental margin and makes its way between the membranes and the uterine wall down to the internal os, whence it passes through the cervix into the vagina. If the hæmorrhage is accompanied by labour pains, this will invariably occur, the effused blood being expelled from the uterus by the contractions.

It is, however, not uncommon for retention of blood within the uterus to occur during accidental hæmorrhage, and it will be generally observed that a considerable mass of blood-clot accompanies or immediately follows the expulsion of the placenta in a case of free external bleeding. In very rare instances, however, almost the whole of the effused blood is thus retained, leading to the condition known clinically as *concealed accidental hæmorrhage*. The most important cause of this retention is probably weakness, loss of tone, or loss of excitability of the uterine muscle, which results in complete absence of uterine contractions. Accordingly the uterus distends easily to accommodate the effused blood, and in time the muscle becomes completely paralysed from great over-distension, and is unable to respond to any stimulus whatever. Other conditions may favour the occurrence of concealed hæmorrhage, such as (1) morbid adhesion of the placental margin, leading to the formation of retro-placental hæmatoma ; (2) morbid adhesion of the membranes around the internal os, preventing the blood from entering the cervical canal. Sometimes, in concealed hæmorrhage, the amnion is ruptured by the effused blood, so that bleeding takes place into the amniotic sac ; more often it is found between the placenta or membranes and the uterine wall. There is usually a little external bleeding in concealed accidental hæmorrhage (Fig. 287). In placenta prævia there is no concealed bleeding.

It will be clear from the above that, in addition to *external* and *concealed* accidental hæmorrhage, a third variety, partly external and partly concealed, may be described.

Sometimes nothing more than a small localised *retro-placental hæmatoma* may be formed (Plate V., 1, p. 157) ; the patient will have no symptoms from such an event, but the fœtus usually dies from asphyxia. Examination of the placenta after labour in such cases reveals a cup-shaped depression on the maternal surface occupied by old blood-clot.

Symptoms and Influence upon Labour.—1. There is only one symptom of *placenta prævia*—viz., visible hæmorrhage. This

symptom may make its appearance in pregnancy, but seldom before the twenty-eighth or thirtieth week, up to which period nothing occurs to indicate the existence of the abnormality. There is no doubt that many cases of abortion occurring between the formation of the placenta and the period of fœtal viability may be due to placenta prævia. In these cases, however, the treatment is simply that of any abortion ; the position occupied by the placenta cannot be clinically recognised, and does not influence the management. From a practical standpoint they therefore belong to a different class from that now under consideration. If a placenta prævia successfully passes the fourth month, there is apparently little tendency to further hæmorrhage until the twenty-eighth week is reached. The bleeding is not accompanied by pain, unless labour starts simultaneously. The onset is usually spontaneous, and often occurs during sleep ; but, as already explained, a history of traumatism may be met with. The first attack may cease spontaneously in a few hours, but there is a marked tendency to recurrence, and by repeated hæmorrhages at intervals the patient may become exsanguine before labour sets in.

The general course of labour is unfavourably affected by placenta prævia as follows : (1) Labour is usually premature, and as the capacity of the lower uterine segment is diminished, the presentation is frequently abnormal ; in 352 cases recorded by Bürger and Graf the presentations were—vertex 69·2 per cent., transverse 21·1 per cent., breech (all varieties) 9·4 per cent., but the proportion of transverse presentations in this series is probably unusually high ; (2) the stage of dilatation is prolonged owing to the deficient formation or entire absence (in central cases) of the natural dilator—the bag of waters ; (3) when the hæmorrhage is severe, uterine exhaustion (secondary inertia) may set in ; (4) interference is frequently required to arrest the bleeding temporarily or to terminate labour rapidly ; (5) consequently there is increased risk of serious laceration of the cervix and lower uterine segment ; (6) puerperal septic infection is a relatively frequent sequel, being accounted for partly by the frequency of operative interference and of serious cervical tears, and partly, as is well recognised, from diminution in the patient's powers of resistance to infective processes, brought about by loss of blood ; (7) the life of the fœtus is jeopardised by premature separation of the placenta, which may cause asphyxia (p. 577), by prolapse of the cord, or by the interference required to terminate labour.

During the first stage of labour hæmorrhage proceeds either continuously or in irregular gushes, or the vagina may become filled up with masses of blood-clot. Towards the end of this stage the hæmorrhage abates, because the presenting part compresses the placental site in passing through the dilated lower

segment. After the expulsion of the body the placenta becomes completely detached, and is usually expelled immediately after the fœtus. Unless secondary uterine inertia sets in, the bleeding then ceases.

2. *Accidental hæmorrhage* is characterised either by *external bleeding*, or by the signs and symptoms of *concealed uterine hæmorrhage*. It is apt to occur especially in women who are more or less ill from pregnancy toxæmia, or sometimes from general causes. It is probable that many cases of abortion occurring after the third month are due to detachment, by traumatism or disease, of the normally situated placenta, and these are technically cases of accidental hæmorrhage. It is, however, convenient, as already explained, to restrict this term to cases occurring after the period of viability of the fœtus has been attained. It is therefore obvious that in cases of accidental hæmorrhage, with *external* bleeding coming on during the seventh or eighth month, the symptoms will closely resemble those of placenta prævia. Even if a history of traumatism is obtained, it does not necessarily follow that the case is one of accidental hæmorrhage ; the differential diagnosis can only be made in the manner to be described later on.

In *concealed* accidental hæmorrhage we have one of the most serious accidents that can possibly happen to a pregnant woman. In a severe case there is a characteristic train of signs and symptoms, which are due to two factors : (1) loss of blood ; (2) paralysis and over-distension of the uterus.

(1) It must be recollected that in these cases the amount of blood which escapes externally is, or may be, only a very small proportion of that which has escaped from the vessels and is retained in the uterus. The general signs of hæmorrhage are, therefore, of great importance as the best indication of the real amount of bleeding which has occurred. The loss of a moderate amount of blood by internal hæmorrhage will in women of average physique induce only a certain pallor, quickening of pulse rate, and perhaps tendency to faintness. The loss of a large amount of blood, sufficient to endanger life quickly, leads to a fall of temperature below normal, to great feebleness as well as rapidity and perhaps irregularity of the pulse ; the skin surfaces become cold and slightly moist from sweating ; finally, the patient becomes restless, and the breathing becomes deep and laboured (air-hunger) : she loses consciousness and may die in a convulsion. The association of deep pallor, a rapid pulse of 120—140, so feeble as to be difficult to count at the wrist, and a subnormal temperature indicates that the case is urgent and must be dealt with without loss of time. The occurrence of minor degrees of concealed hæmorrhage may sometimes be diagnosed by noting, in an apparent case of external hæmorrhage, that the con-

stitutional disturbance is disproportionate to the amount of blood lost.

(2) Over-distension of the uterus causes severe, continuous, and increasing abdominal pain, combined with shock. On examination *per abdomen* it will be observed that the uterus is unduly large and very tender, and sometimes so tense as to feel almost wooden in consistence ; no contractions can be made out ; the fœtal parts cannot be detected nor the sounds of the fœtal heart heard. If progressive increase in size of the uterus, in the course of a few hours, can also be made out, the presence of concealed bleeding is certain. On vaginal examination a little bleeding from the uterus will usually be detected, although in rare cases there is none. The temperature will be subnormal ; the pulse will be rapid—over 120 ; there will be pallor, or absolute blanching of the skin and mucous membranes.

The worst cases of concealed accidental hæmorrhage are accompanied by complete paralysis of the uterine muscle ; the cervix is usually undilated, and not only are there no spontaneous uterine contractions, but it is extremely difficult to obtain any response to the ordinary methods of excitation.

Clearly a certain resemblance exists between this condition and tonic uterine contraction (see p. 411). In concealed hæmorrhage, however, the uterus is larger than normal, but in tonic contraction it is smaller ; and while signs of internal hæmorrhage are conspicuous in the former, in the latter the signs are those of ' obstetric exhaustion ' with some rise of temperature. Lastly, in tonic contraction the cervix is always considerably dilated, and the presenting part impacted, while in concealed hæmorrhage the cervix is small and the presentation obscure. Accordingly, errors in diagnosis need not occur.

In *external* accidental hæmorrhage the course of labour is unfavourably affected, in very much the same manner as in placenta prævia. But much greater variation in the amount of hæmorrhage is met with in the former than in the latter ; many cases of accidental hæmorrhage are trivial, but placenta prævia is nearly always serious. Labour is usually premature ; tedious from partial uterine inertia ; dangerous to the mother on account of loss of blood, and on account of the frequent necessity for operative interference increasing the risks of sepsis ; dangerous to the fœtus from risks of asphyxia by premature separation of the placenta, or of injury during intra-uterine operations. Generally speaking, accidental hæmorrhage does not show the same tendency to recurrence as does placenta prævia. Although recurrences either before labour or when labour sets in are common, they are by no means invariable, as in the case of placenta prævia. Cases are accordingly not infrequent in which, after a single slight or moderate bleeding

of the accidental type, pregnancy is completed and labour brought to a close without further hæmorrhage.

Differential Diagnosis.—The differential diagnosis between placenta prævia and accidental hæmorrhage can only be made with certainty by recognising in the former that the placenta occupies the lower uterine segment. It is said that this may sometimes be done by palpation and auscultation *per abdomen*, but this is doubtful. When the cervix is closed it may be surmised that the placenta occupies the lower segment from the consistence of the uterine wall as felt through the vaginal fornices ; an unusual extent of soft resistance may here be felt, obscuring the presenting part and making the detection of ballottement difficult. The presence of the placenta in the lower segment interferes with the descent of the presenting part, and renders engagement of the head in the brim before labour impracticable. If, therefore, the head is found engaged, the case is more likely to be one of accidental hæmorrhage.

The only conclusive method is to pass the finger through the internal os, when the placenta can be recognised by direct touch. If the edge of the placenta is within reach its recognition by the finger is fairly easy, from its rounded contour and the sharp line of transference from placenta to membranes. When the edge cannot be reached a little care is required to distinguish retained blood-clot from placental tissue, the much greater friability of the former being the chief point of distinction between them. This method is, of course, only applicable when the internal os has begun to dilate ; but after a severe hæmorrhage there is usually sufficient dilatation for the diagnosis to be made in this manner ; during labour no difficulty will be encountered except in marginal cases early in labour, when the placental edge may lie so far away from the os as to be beyond the reach of the finger. When the placenta cannot be felt in the lower segment the diagnosis of accidental hæmorrhage must be made. The presence of albumen in the urine points to accidental hæmorrhage rather than to placenta prævia ; the frequency with which accidental hæmorrhage is associated with toxic albuminuria has been pointed out. Cases of concealed hæmorrhage are never due to placenta prævia.

Treatment before Labour.—Before labour slight cases of *accidental hæmorrhage* should in the first place be treated by palliative measures. Complete rest in bed should be enforced, and continued for at least a week after all bleeding has ceased ; a daily aperient, and light diet without stimulants, should be enjoined. Sedatives will be indicated in most cases, some form of opium being undoubtedly the most useful. Ergot has been advised in small doses—10 to 20 minims of liquid extract three times a day ; but it is very doubtful whether it exerts any appreciable effect. A hypodermic injection of $\frac{1}{4}$ grain of

morphia may be given in the first instance, and repeated in doses of $\frac{1}{8}$ grain if the bleeding continues. In cases where the external loss is slight, a careful watch should be kept for the signs of concealed bleeding. Recurrence of bleeding does not necessarily take place, and even when labour occurs there may be no more hæmorrhage. Palliative treatment should not be continued for more than twenty-four hours, when it fails to control serious bleeding. After a single severe hæmorrhage labour usually sets in spontaneously, unless the uterine muscle becomes paralysed from over-distension.

In the case of *placenta prævia* palliative treatment should not be adopted under any circumstances, even if the patient can be kept under continuous observation. The temporary cessation of hæmorrhage must not be allowed to give a false sense of security and an excuse for temporising, for at any moment a serious, and even a fatal, hæmorrhage may occur. Labour should be at once induced as soon as the diagnosis of placenta prævia has been made. The best method of induction is the use of de Ribes' bag, with version later on if necessary (*vide infra*).

Management of Labour.—The management of labour complicated by ante-partum hæmorrhage must be guided by the following principles: (1) In all severe cases the immediate indication is to control the bleeding, and then to delay delivery until there has been time for the patient to recover from the shock of a severe hæmorrhage, and for the labour to make progress; (2) permanent arrest of the hæmorrhage can, however, only be ensured by complete *evacuation* and *retraction* of the uterus; therefore the risk of recurrence will continue until delivery has been completed; (3) in severe cases the chances of the fœtus surviving are so slight that treatment may be directed solely to the interests of the mother.

Temporary arrest of hæmorrhage is much more practicable in placenta prævia than in accidental hæmorrhage; in the former the placental site in the lower uterine segment is accessible from the vagina, and may be subjected to direct compression in various ways; in the latter the placental site cannot be localised and is inaccessible to direct compression. The effect of uterine contractions in the two cases is also different: in placenta prævia the lower segment is progressively dilated and the placental site progressively denuded by the uterine contractions, which accordingly tend to increase the bleeding, until that part of the placenta which occupies the lower segment is completely detached; in accidental hæmorrhage each contraction temporarily diminishes the maternal blood-flow to the placental site, and presses the separated placenta against the fœtus, and accordingly tends for the moment to check bleeding. Uterine contractions are, in point of fact, the only means we possess of

temporarily controlling accidental hæmorrhage, and treatment is therefore directed to exciting them to the greatest possible activity. In both varieties of ante-partum hæmorrhage, elevating the foot of the bed for 10 to 12 inches is believed to check the bleeding slightly and is usually practised.

Treatment of Severe Cases of Placenta Prævia.—In nearly every case of placenta prævia in which considerable bleeding has occurred, whether in labour or not, the cervix will be found to be sufficiently dilated to admit one finger or sometimes two fingers. Two methods of treatment are then available, either of which will immediately arrest bleeding by compressing the placental site, and will also, after an interval, excite labour. These methods are (*a*) pulling down a leg so as to plug the lower uterine segment and cervix with the half-breech ; (*b*) introducing the hydrostatic dilator of de Ribes into the uterus so as to produce the same effects. Each of these methods has advantages in some respects over the other, and opinion is accordingly divided as to which should have the preference. It will be convenient first to describe these methods and then compare their merits.

(A.) *Pulling down a Leg.*—If the presentation is vertex or transverse, the fœtus must be turned in order to allow of the leg being brought down within reach of the fingers passed into the cervix. As it is very desirable to avoid unnecessary internal manipulations, version should be performed by the external method if possible (p. 601) ; under anæsthesia this can usually be done, even when labour is in progress, if the membranes have not ruptured, and an anæsthetic will in all cases be required in order to pass the fingers through the cervix. A pelvic presentation having thus been produced, the vulva should first be shaved ; afterwards the vulva and vaginal canal should be thoroughly swabbed with ether soap, then dried with sterile swabs and freely painted over with tincture of iodine. The operator should also wear sterilised rubber gloves. The most stringent antiseptic precautions are called for, as the denuded portion of the placental site, with its large open vessels, is within the area of the manipulations, thus allowing direct absorption into the circulation, and tending to make the results of even slight degrees of infection very serious. Bi-polar combined version (p. 615) should therefore be avoided whenever the fœtus can be turned by the external method. When the breech has been brought over the pelvic brim it is usually easy to find a foot, if two fingers can be passed into the cervix ; the only difficult cases are those of central insertion, when the placental tissue over the os must be first torn through with the finger. The membranes should then be ruptured, and the foot seized by the ankle and pulled down into the vagina. If the legs should be extended and the feet consequently out of reach, it is impossible

at this stage of labour to pull down a leg at all, and the alternative method of treatment by de Ribes' bag must be adopted.

A certain amount of fresh bleeding is necessarily caused by these manipulations, but by exerting gentle continuous traction on the foot the half-breech may be pulled down into the lower uterine segment (Fig. 288) so as to plug it firmly, and directly to

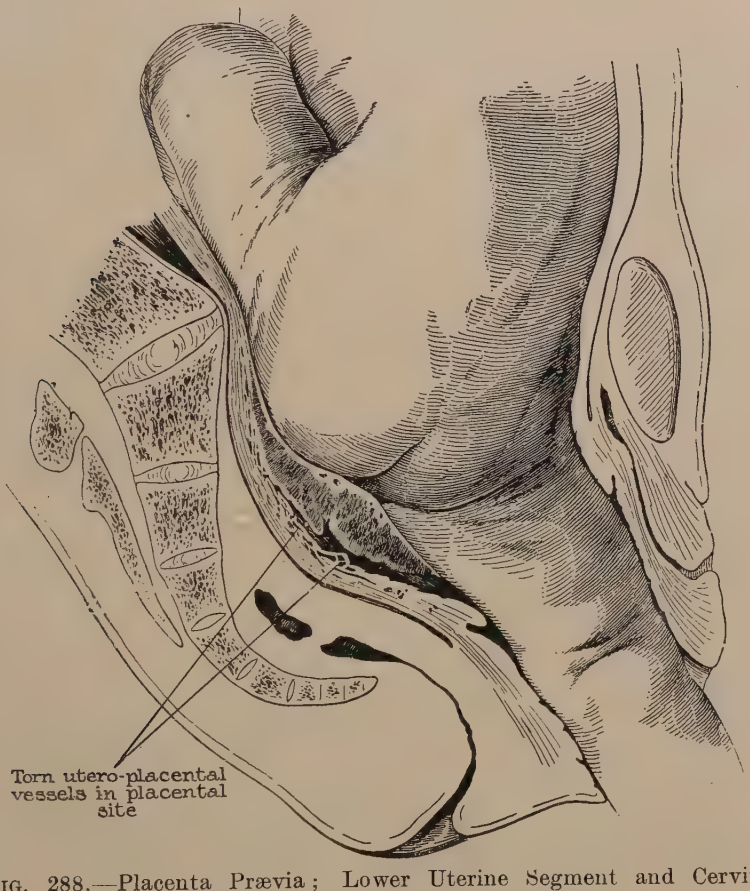


FIG. 288.—Placenta Prævia; Lower Uterine Segment and Cervix plugged by the Half-Breech. (Bumm.)

compress the placental site. A degree of traction just sufficient to arrest bleeding may be kept up steadily by means of a tape tied to the foot. Very little exercise of force is required to prevent further hæmorrhage, and great gentleness is called for because (1) it is not desirable to hurry the delivery of the fœtus; (2) serious laceration of the cervix running up into the lower segment and opening the placental sinuses is very

readily caused in placenta prævia ; this may result in troublesome post-partum hæmorrhage, and it increases the risks of sepsis. Continuous traction may be applied by attaching a weight of 1 to 2 pounds to the foot-tape, carried over a pulley at the foot of the bed.

After a leg has been pulled down it is essential that an interval should be allowed to elapse before delivery, if there has been serious bleeding ; profuse hæmorrhage is not an indication for rapid delivery in placenta prævia, for the shock caused by rapidly emptying the uterus may prove fatal to patients already suffering severely from the constitutional effects of hæmorrhage. When this procedure is adopted in patients not actually in labour, effective labour pains usually begin within twelve hours ; there is no more powerful or certain method of exciting active uterine contractions. If labour has already begun the process will be expedited, but the expulsion of the body of the fœtus should be left entirely to the natural forces, and no attempt made to deliver by traction. It will be recollected that the same rule has been already laid down for ordinary breech labour, on account of the increased risks of extension of the arms or head occurring when traction is made. In the case of placenta prævia the additional object of delay is to allow time for recovery from shock and hæmorrhage, for gradual dilatation of the cervix, and for the application of restorative measures to the mother. In severe cases the same restorative methods may be employed as in bad cases of post-partum hæmorrhage (p. 478).

When labour pains become effective and the body of the fœtus is gradually expelled, no further serious bleeding will occur, for the trunk and head of the fœtus, successively, plug the lower segment and compress the placental site. As soon as the fœtus has been delivered the third stage should be completed as rapidly as possible, for post-partum hæmorrhage frequently occurs from imperfect retraction, and when there have already been profuse losses of blood even a moderate amount of post-partum bleeding may prove fatal. Therefore the placenta should be at once expressed, or if this cannot be done it should be digitally removed. As a rule, expression is easy because the placenta has already been extensively detached. A very copious antiseptic intra-uterine douche should always be used after delivery in cases of placenta prævia.

(B.) *Introducing de Ribes' Dilating Bag.*—This appliance, and the details of the method of using it, will be found fully described on p. 593, in the section on Obstetric Operations. Like the method just described, the dilator acts (1) in temporarily arresting bleeding by compressing the placental site ; (2) in exciting labour pains. As the uterine contractions become effective the cervix is mechanically dilated to the size

of the broad end of the bag (see Fig. 333). It is unnecessary to turn the fœtus, as the method is applicable in all presentations. Just before introducing the bag the membranes should be ruptured so that the dilator will lie within the amniotic cavity. It is therefore easier to introduce it in cases in which the edge of the placenta is within reach. When it has been introduced and inflated gentle traction may be exercised in order to keep up continuous compression of the placental site.

As a means of arresting hæmorrhage the bag is effective; but it is inferior to pulling down a leg as a means of exciting labour pains. When traction is used, the bag will often dilate the cervix without inducing effective labour pains at all. When the cervical canal has been dilated to the full size of the bag, the latter passes out of the uterus into the vagina. If the uterus is now contracting actively, so as to drive the presenting part well down into the cervix, bleeding will not recur to any serious extent. But if the uterus is inactive, the removal of the compressing force may lead to a sudden profuse loss of blood when the bag passes into the vagina. In this respect, therefore, the method is decidedly inferior to pulling down a leg, for in the latter compression is necessarily maintained until the fœtus has been delivered.

After the bag has done its work in dilating the cervix it is usually necessary to adopt some method of operative delivery such as forceps or internal version, and the patient must be most carefully watched in order that there may be no delay in doing what is required if bleeding recurs after the expulsion of the bag. When the bag has been expelled and the uterus is inactive, delivery must not be delayed; version under anæsthesia is the method of choice in such cases. Delay may be followed by further profuse bleeding, which greatly increases the risks of the subsequent extraction of the fœtus. If forceps is used the greatest care is called for, as the head will be disengaged, and high up in the pelvis (see p. 638); as the head is pulled down into the pelvis the bleeding will cease from efficient compression of the placental site.

Comparison of Methods.—For the *dilating bag* the case most suitable are those of *lateral* and *marginal* placenta prævia, where the membranes are within reach and the bag can be pushed through them. Cases of *central* insertion, on the other hand, should always be treated in preference by version for the following reasons: (*a*) the fœtus dies before delivery in almost all central cases owing to the extensive separation of the placenta; (*b*) the amount of bleeding is always severe, and the condition demands such methods of treatment as will minimise subsequent hæmorrhage; (*c*) version is the easiest method of trans-placental delivery. Having brought down the half-breech in a central case, delivery should not be at once completed: the more

serious the condition of the mother the more necessary is it that this precaution should be observed. The time gained after arrest of bleeding should be spent in restorative measures, and delivery may then occur spontaneously later on. Continuous gentle traction on the breech may be necessary to arrest bleeding completely.

It may be said that all cases of placenta prævia are suitable for *version*. The fœtal mortality with this method is probably higher than with the hydrostatic bag. On the other hand, the risks to the mother are less with version. The general rule which should be observed is that the bag may be used in the less severe class of cases where the amount of bleeding has been comparatively small. In all cases where the amount of bleeding has been severe, and in central cases even when the bleeding has not at the time been alarming, version should be preferred. The maternal risks in central cases are so serious as to forbid us to allow them to be increased by adopting measures designed in the interests of the fœtus alone.

It must further be observed that when the bag is used the patient requires continuous medical supervision, for its expulsion may be immediately followed by profuse bleeding. With version, however, delivery may occur spontaneously without further loss of blood. Under the conditions generally found in private practice the method of version, for this reason also, is to be preferred.

Treatment of Slight Cases of Placenta Prævia.—In slight cases two methods are available much simpler, and causing much less interference, than those just described; they are (*a*) plugging the cervix and vagina and (*b*) rupturing the membranes. *Plugging* is carried out in the manner to be described in connection with the treatment of accidental hæmorrhage (p. 462). Large quantities of plugging are required, and the upper part of the vagina must be tightly packed if the plug is to be effective. This method is mainly applicable to cases in which labour has not begun, or the cervix is not sufficiently dilated to admit two fingers. Under these conditions it will arrest bleeding, and in some cases also will start labour pains. The chief objection to it is the difficulty of maintaining efficient asepsis. That this is a practical objection is shown by the fact that even in lying-in hospitals cases treated by plugging show a higher percentage of septic complications than those treated by any other method. It should therefore not be adopted except in an emergency.

Rupture of the Membranes.—This method is very useful when the head or breech presents, the placenta is marginal or lateral, and the amount of bleeding slight ; unless labour is already in progress the conditions for its performance are not entirely favourable, for as a means of inducing labour it is unreliable. Free escape of the liquor amnii permits the presenting part to

descend completely into the lower uterine segment, and fill it so as to compress the placental site ; at the same time the force and frequency of the uterine contractions are increased. Care must be taken that a loop of cord does not become prolapsed. If the shoulder presents it is contra-indicated. If the breech presents it should be followed by pulling down a leg as soon as sufficient dilatation has been accomplished.

Cæsarean Section in the Treatment of Placenta Prævia.—Cæsarean section is becoming increasingly more prominent in the treatment of placenta prævia. It is done chiefly in cases of central insertion, for in these the mechanical difficulties of delivery by the natural passages are the greatest and the hæmorrhage is always severe. It should be considered in all cases in which there has been serious hæmorrhage, and in which from the position of the placenta it is anticipated that delivery cannot be effected without further loss of blood ; it is especially indicated in complete placenta prævia when labour has not begun and the cervix is closed and resistant. In such cases Cæsarean section performed after the first attack of bleeding offers almost the only chance of the survival of the fœtus, and is less dangerous to the mother than delivery by the natural passages. But, given skilled operating and the proper environment, Cæsarean section need not be limited to the above class of case. Provided the patient is in good condition, the mortality of Cæsarean section for placenta prævia should be no higher than for contracted pelvis—viz., two or three per cent. ; the mortality of placenta prævia treated conservatively, even in skilled hands, is certainly higher than this. Cæsarean section is not contra-indicated by the death of the fœtus, for the operation is mainly undertaken in the maternal interests. In order to reduce operative shock the operation should be performed by spinal or by gas and oxygen anæsthesia. Intravenous saline transfusion may be indicated during the operation.

Treatment of Accidental Hæmorrhage.—The great principle of treatment is to excite vigorous labour pains ; the bleeding comes from that part of the uterine wall which is capable of contraction and retraction, and is nearly always controlled when strong labour is established.

1. *When the hæmorrhage is external.*—In the early stages of labour, the cervix being closed or only large enough to admit two fingers, two methods of treatment are applicable—viz., vaginal plugging and rupture of the membranes. The former is the method introduced and advocated at the Rotunda Hospital, Dublin, and now generally accepted and practised. The object in view is two-fold—firstly, to stimulate the uterus and so induce effective labour pains ; secondly, to prevent further hæmorrhage. The vaginal plug is reputed to control bleeding directly, by exerting pressure on the uterine arteries. It is

also claimed for it that by preventing the escape of the effused blood, when the uterus is actively contracting, the intra-uterine pressure will be raised to a point at which it equals or exceeds the blood-pressure in the placental sinuses, and accordingly the bleeding will cease spontaneously ; it is clear that this effect will not be produced unless the plug excites effective uterine contractions. Before plugging, the vulva should be shaved, and, after thorough antiseptic douching, the vulva and vaginal walls should be carefully dried with sterile swabs and then freely swabbed with tincture of iodine. An anæsthetic is necessary. Better directions cannot be given than those of Hastings Tweedy. "To plug efficiently the left hand should be passed into the vagina with the palmar surface directed towards the hollow of the sacrum, while the tips of the fingers lie behind the cervix. Small pieces of cotton wool, squeezed out of lysol solution, and each the size of the thumb knuckle, are then taken and inserted by means of the right hand round the cervix. The fingers of the left hand are kept busy squeezing the pellets into a compact mass and forcing the spaces between them to permit the insertion of still another plug. This process is continued in a systematic manner from above downwards till the vulva is reached and the vagina can hold no more. A T-bandage is applied to keep the plug in position, and an abdominal binder is fastened tightly from above downwards to press the side walls of the uterus against the vaginal dam, and thus complete the operation. A plug so applied will cause immediate cessation of hæmorrhage, and, when it is removed after the lapse of hours, so much blood only will be found as can be accounted for by the flow which took place during the operation." Uterine stimulants should also be given—*e.g.*, 1 c.c. of pituitrin, by intra-muscular injection, but whenever the uterus begins to act powerfully the plugging should be removed, as it has then served its purpose, and the course of labour can be better watched without it. Unruptured membranes are of great assistance in maintaining intra-uterine tension. If uterine contractions are not powerfully excited, this treatment may convert the case into one of concealed hæmorrhage by preventing the escape of effused blood. This untoward result does undoubtedly occur, but experience shows that plugging by this method rarely fails to excite effective contractions.

It has been already mentioned that vaginal plugging is difficult to carry out under complete asepsis, and that septic complications are frequent after its use. The risk of sepsis is probably less in accidental hæmorrhage than in placenta prævia on account of the low position of the placenta in the latter. The efficiency of the method in suitable cases and the simplicity of its requirements render it of real value in accidental hæmorrhage.

Rupture of the membranes should be reserved at this stage for

cases in which labour has begun and in which the bleeding has either ceased or the amount being lost is inconsiderable; its object is to excite more effective contractions and thus accelerate labour. Afterwards a tight abdominal binder should be applied, and 1 c.c. of pituitrin given by intra-muscular injection.

The matter may therefore be summed up by saying that in the early stages severe cases of external accidental hæmorrhage should be treated by plugging, slight cases, if in labour, by rupturing the membranes; in each case uterine stimulants should also be given.

In the further management of labour it must be recollected that in many cases accidental hæmorrhage ceases spontaneously, and after a severe loss at the beginning of labour no more bleeding may occur. Or if the bleeding recurs, it is not necessarily in large quantity. In this respect the conditions are very different from placenta prævia, in which hæmorrhage continues throughout the stage of dilatation unless checked by treatment. When the bleeding has ceased or is inconsiderable, de Ribes' bag may be used for dilating the cervix, so that delivery may be rapidly completed by forceps or version.

2. *When the hæmorrhage is concealed.*—In severe cases of concealed hæmorrhage there is complete uterine inertia, and it is almost impossible to induce *effective* labour pains owing to paralysis of the uterine muscle from over-distension. The intra-uterine tension may reach a point at which it is sufficiently high to arrest further bleeding. It is clear that in this condition rupturing the membranes is likely to do harm, for by reducing intra-uterine tension fresh bleeding may arise from the placental site. This should consequently never be attempted.

The ideal treatment for severe concealed hæmorrhage is Cæsarean section under spinal anæsthesia. It is not necessary to remove the uterus, as it will always contract if given time and stimulation; nor do interstitial hæmorrhages necessarily impair its value as a future child-bearing organ. If Cæsarean section is not available, these cases must be treated by the vaginal plug and pituitary extract. Active treatment, by Cæsarean section or the vaginal plug, is not always necessary; in cases of moderate severity, nothing need be done beyond giving pituitary extract and applying a tight binder, the patient's general condition and pulse-rate and the size of her uterus being carefully watched. Very often labour pains will begin, a fact which is proclaimed by the appearance of external hæmorrhage, and the patient delivers herself safely. It requires great judgment to adopt this line of treatment, and it should only be done in the presence of all facilities for instant operation should there be signs that hæmorrhage is progressive. As may be expected, a high maternal mortality attends this very serious condition, by whatever method it may be treated.

Mortality.—Out of 10,000 recent consecutive admissions, 119 cases of placenta prævia were treated at Queen Charlotte's Hospital. The maternal mortality in these cases was 10 per cent., but it must be remembered that many of these cases were admitted during labour, after severe bleeding had occurred, and various methods of treatment had been applied. The fœtal mortality in the same series, calculated upon the number which died either during delivery or before leaving the hospital, was 67 per cent. During the same period 129 cases of accidental hæmorrhage occurred with a maternal mortality of 4 per cent. and an infantile mortality of 58 per cent. These figures illustrate very well the greater seriousness of placenta prævia from the point of view of the maternal risks, and also the heavy fœtal mortality which attends both varieties of ante-partum hæmorrhage. The fœtal mortality is in part accounted for in both cases by prematurity. In the majority of the fatal cases of placenta prævia the insertion was central. Accidental hæmorrhage is seen to be both more frequent, and on the average less serious, than placenta prævia. In addition to the maternal *mortality*, there is a relatively high rate of puerperal morbidity from septic complications.

(VII.) RETENTION OF THE PLACENTA

The natural expulsion of the placenta may be prevented (*a*) by *uterine inertia*, (*b*) by *morbid adhesion* of the placenta or membranes to the uterine wall, (*c*) by the formation of a *contraction ring :* in all these conditions severe hæmorrhage may occur unless the placental attachments remain undisturbed. If the placenta retains its complete attachments undisturbed there will be little hæmorrhage, for none of the utero-placental vessels have been torn ; when, however, it is in part but not wholly detached, and the uterus is unable to expel it into the cervix, uterine retraction is impeded, and free bleeding occurs from the imperfectly closed mouths of those vessels which have been torn. Though the normal processes of separation and expulsion of the placenta and membranes are always accompanied by hæmorrhage, the amount does not usually exceed 4 to 10 ounces, and is not enough to quicken the pulse-rate or affect the general condition of the mother. Unusually free bleeding at this period (third stage) is always due either to *incomplete detachment* of the placenta or to *laceration* of some part of the genital canal—the cervix, vagina, or vulva. The latter will be considered in the next section in connection with post-partum hæmorrhage.

(1) *Retention of the Placenta : Non-detachment.*—In this condition spontaneous delivery of the placenta does not occur,

and the after-birth remains in organic union with the wall of the uterus, although its attachments are not abnormal. The cause of the non-detachment of the placenta must be inadequacy of uterine retraction and contraction, for no abnormality can be detected in the placental attachments. Sometimes no hæmorrhage occurs ; more frequently a portion of the placenta becomes separated, and then there is hæmorrhage, which may be very profuse, some of the most serious cases of post-partum hæmorrhage being met with before the placenta has been delivered. A practitioner in a hurry may be tempted to diagnose *retention* whenever the placenta is not expelled within a few minutes after the delivery of the child ; this is unjustifiable, and at least an hour should be allowed to elapse, unless there is unusual hæmorrhage, before the case is regarded as abnormal. When there is no hæmorrhage the condition is not urgent, and delay can do no harm ; if there is much hæmorrhage no delay can, of course, be allowed. If the placenta cannot be expressed the treatment consists in digital removal of the placenta from the uterus. In the case under consideration, no difficulty whatever attends the detachment of the placenta by the fingers, showing that there is no structural abnormality. But this operation, though simple and easy, is attended by great risks, and should never be undertaken merely to save time.

(2) *Morbid Adhesion of the Placenta.*—The pathology of this condition is imperfectly understood. Clinically it is characterised by unusual firmness of the placental attachments, in consequence of which spontaneous delivery is rendered impossible. It is rare for the whole placental site to be thus affected ; usually the change is partial. It is attributed, and with probability, to inflammatory changes in the decidua, resulting in the formation of more or less extensive, firm, organic connections with the uterine wall. From this view it is easy to proceed to the assumption that some form of decidual endometritis is the original lesion ; and this assumption is supported by the observation that the condition not infrequently recurs in successive pregnancies. But pathological proof has not yet been advanced, because it is difficult to obtain material in a suitable condition for histological examination, inasmuch as the placenta, in these cases, is usually removed in fragments torn from the uterine wall. De Lee has described a case in which he found abnormally deep penetration of the villi at the placental site, possibly the consequence of unusually active trophoblast in the early weeks of pregnancy.

Morbid adhesion of the placenta usually causes severe hæmorrhage in the third stage, but sometimes there is little or none. The amount of bleeding depends mainly upon the extent of the adherent area ; when this is large, only a small

part of the placental site can be laid bare—*i.e.*, can give rise to hæmorrhage ; when the adherent area is small, a large extent of the placental site may be denuded and thus cause severe bleeding.

Simple *retention* and *morbid adhesion* of the placenta can only be distinguished from each other by digital separation of the after-birth. In the former condition this is easy ; in the latter

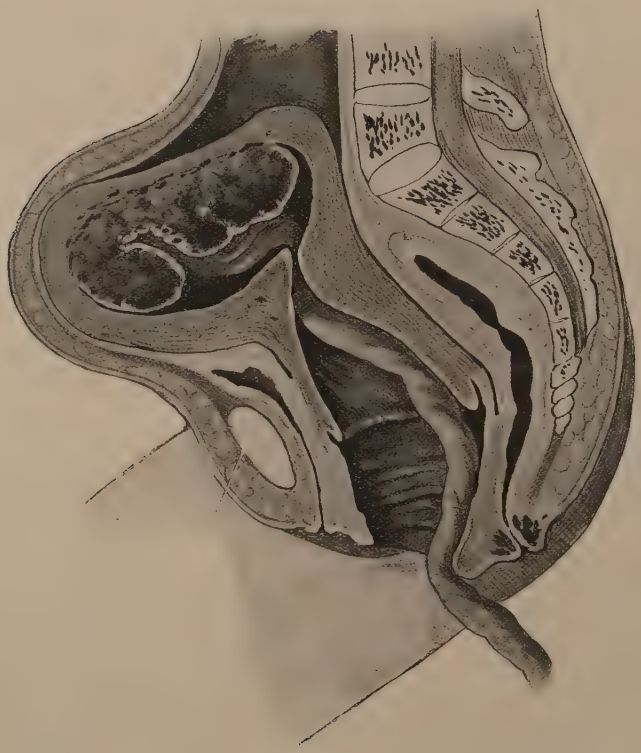


Fig. 289.—Retention of the Placenta due to a Contraction Ring. (After Bumm.)

it is difficult owing to the presence of dense fibrous bands which must be torn through, or owing to firm union between the placental and uterine surfaces. The treatment of a morbidly adherent placenta is the same as of a retained placenta—viz. to remove it by intra-uterine manipulation.

(3) *Morbid Adhesion of the Membranes.*—When this occurs, the placenta, though expelled from the uterine cavity, remains suspended in the cervix or vagina by non-separation of the chorion from the uterine wall (Fig. 140), and cannot be delivered

by voluntary expulsive efforts or by gentle compression. Abdominal examination shows that the placenta has left the uterus. If energetic compression of the uterus is practised, the placenta may be torn away and expelled with the amnion, leaving a large part of the chorion in the uterus. In point of fact this is what usually occurs in such cases, and the fact that the membranes are morbidly adherent is not recognised until

FIG. 290.—Introducing the Hand into the Vagina.

the after-birth has been delivered, when it is found on examination that the chorion is deficient. The amnion is seldom adherent and usually comes away entire with the placenta. When it is found that a piece of the chorion has been torn off, a vaginal examination should be made, and if the piece is found hanging down into the vagina it should be carefully removed by twisting it with a pair of forceps. If the end cannot be felt in the vagina, nothing further should be done; the piece of

membrane will become detached and spontaneously expelled during the first seven to ten days of the puerperium, and if efficient asepsis has been secured, no harm results. The alternative is to explore the uterus by passing the whole hand into it, and this procedure, even when carefully carried out, often results in bacteria being carried from the vulva into the uterus. Membrane retained in the uterus should only be removed if there is hæmorrhage. A high percentage of morbidity from sepsis is found in cases in which the hand has been passed into the uterus during or after the third stage of labour.

(4) *Contraction Ring* (Hour-glass Contraction).—The causation of this condition has been already discussed (p. 412) in connection with its occurrence in earlier stages of labour. In the third stage it causes great narrowing of the lumen of the uterus and prevents the expulsion of the placenta. The upper part of the uterine body, which, though retracted, is lax and contains the placenta, is separated by a ring of spasm from the lower segment and cervix, which are also lax ; hence the name of hour-glass contraction which has been applied to it (Fig. 289). The condition occurs after prolonged or difficult labour, and particularly after bad management, such as attempts to deliver by forceps in unsuitable conditions, but the administration of ergot before delivery, at one time regarded as the principal cause, has probably little to do with its causation. A similar condition may occur in the first and second stages of labour, and has been already referred to.

If the placenta becomes partly or wholly separated, there will be severe hæmorrhage, for its expulsion through the ring of spasm is impossible ; if not, there will be none. In the former case immediate removal of the placenta is called for ; in the latter it is best to wait for two or three hours before attempting removal, in order to get rid of the local spasm ; this may be aided by the administration of a full dose of morphia hypodermically ($\frac{1}{2}$-grain). Considerable difficulty may be experienced in dilating the ring of spasm, if the operation has to be undertaken immediately.

Sometimes the presence of a fibroid tumour in the lower part of the uterine wall will offer the same kind of obstacle to spontaneous expulsion, and the same kind of difficulty in artificial delivery, as irregular retraction.

Digital Removal of the Placenta.—This operation should not be lightly undertaken, for it is by no means devoid of risk. An anæsthetic should be given, and the patient placed in the dorsal position with the legs supported by attendants, or by a Clover's crutch. The most scrupulous antiseptic precautions must be taken in sterilising the hands, and a pair of sterilised rubber gloves should be used in all cases. The vulva and vagina should be sterilised by freely swabbing with tincture of iodine

after previous shaving. A hot (118° F.) intra-uterine douche should be prepared for administration at the close of the operation. Either hand may be passed into the vagina, the other being employed to steady the uterus. The fingers and thumb should be bent into the shape of a cone (Fig. 290), and the whole hand gently introduced through the vulva, the labia being separated with the fingers of the other hand ; the whole hand

Fig. 291.—Digital Separation of the Placenta.

may then be passed up *between the membranes and the uterine wall* until the lower placental border is reached. If the fingers are inadvertently passed inside the collapsed amniotic sac, they must be withdrawn and re-introduced outside the membranes.

In a case of simple *retention* it will be found to be perfectly easy to insinuate the fingers under the placental edge, and gradually detach it from the uterus, the fingers sweeping the wall on both sides (Fig. 291). This should be continued until

the whole of the placenta has been completely detached ; then the mass is grasped in the fingers and gently withdrawn into the vagina, the membranes being peeled off behind it. The fundus is steadied by the other hand grasping it until the operation is finished. It is important fully to detach the placenta before beginning to remove it, otherwise fragments may easily be torn off and left behind. Every effort should, however, be made to detach the whole of the placenta and sweep it out of the uterus before withdrawing the hand, thus avoiding the necessity of introducing it a second time. Immediately after the placenta has been removed it should be examined, and if it is incomplete the hand must again be introduced and the retained portion removed. A hot intra-uterine douche of several pints of antiseptic lotion should then be administered to stimulate retraction and remove clots, and to counteract the possible effects of the introduction of bacteria. An intra-muscular injection of pituitrin or of ergot should be given, as it is important to make sure that the uterine cavity is completely empty, as described on p. 302. Carelessness in performing this operation may result in perforation of the uterus, incomplete removal of the placenta, or troublesome hæmorrhage ; in spite of precautions, a severe uterine infection frequently occurs in the puerperium.

When there is *morbid adhesion* of the placenta, difficulties will be encountered. In this case it is best to begin with the detached portion, if it can be found. The finger-tips must be used in clearing the uterine wall, and great gentleness is, of course, called for in all the manipulations. Every effort should be made to remove completely the whole of the placenta and chorion, but it is often difficult to make certain that this has been done. So serious is this condition, both in its immediate effects from hæmorrhage and its remote effects from infection, that hysterectomy, by the abdominal or vaginal route, has been advocated; the operation should follow promptly on the diagnosis of the condition, as revealed by the early difficulty encountered in the attempt at digital removal of the placenta.

In *irregular retraction* the difficulty consists in dilating the ring of spasm sufficiently to admit the fingers and allow of the removal of the placenta. A full hypodermic dose of morphia given beforehand assists the anæsthetic in relaxing the spasm. Dilatation should be performed with the fingers alone.

(VIII.) POST-PARTUM HÆMORRHAGE

Hæmorrhage which occurs after delivery is called post-partum hæmorrhage ; its occurrence is most to be feared immediately, or within an hour or two after labour is over. Hæmorrhage occurring after the first day of the puerperium

is called *secondary post-partum hæmorrhage*, or *puerperal hæmorrhage ;* the latter term is preferable, as it is desirable not to confuse it with the form of hæmorrhage under consideration. Many lives have been lost from this complication of labour ; bleeding may occur so suddenly and profusely that, unless it can be checked, death will ensue within half an hour to an hour. A disaster such as this may follow a rapid and apparently an easy labour ; it is therefore of the first importance that its causation, and the principles which underlie its prophylaxis and immediate treatment, should be clearly understood. In proportion as these principles are generally acted upon, post-partum hæmorrhage becomes less frequent and less formidable.

Causation.—There are only three local conditions which can be regarded as immediate causes of post-partum hæmorrhage—viz., *uterine exhaustion* or *inertia*, *mechanical obstacles to retraction*, and *lacerations* of some part of the genital tract (cervix, vagina, vulva) ; in the two former the bleeding comes from the torn utero-placental vessels (placental site), in the latter from torn vessels at the seat of injury. Uterine exhaustion at this period implies failure, more or less complete, of both contraction and retraction—*i.e.* it is identical with the condition previously described as secondary inertia (p. 409). Cases of real gravity which imperil or destroy life are generally due to this cause ; it is obvious that exhaustion of the uterus, when the placenta has been separated, will allow of hæmorrhage of the most profuse kind, for muscular action is the only effectual means of closing the mouths of the torn utero-placental sinuses. The circumstances which may lead directly or indirectly to post-partum uterine inertia must therefore be carefully borne in mind ; they can be conveniently grouped into *predisposing* and *immediate* causes. As they have all been previously considered in detail, little more than an enumeration of them is here required.

Predisposing Causes of Post-partum Inertia.—Multiparity, especially when associated with rapid child-bearing, is the most important ; such cases, in other words, as are liable to secondary inertia during labour. *Over-distension* of the uterus (twins, hydramnios), *ante-partum hæmorrhage*, *secondary inertia* during the second stage, *protracted* or *precipitate labour*, and *prolonged anæsthesia*, must all be regarded as conditions which increase the risks of the occurrence of post-partum inertia.

Immediate Causes of Post-partum Inertia.—Artificial delivery of the child during a period of *secondary inertia* involves serious risk of post-partum hæmorrhage, as has been already explained in another place. It may be repeated here that absolute cessation of the pains of labour forms a contra-indication to delivery. One of the causes most frequently met with is *mismanagement of the third stage* of labour. The importance of continuously watching the uterus during and after this stage

has been pointed out ; if this precaution is neglected the uterus may fill with blood and even become distended (relaxed) without any external bleeding attracting attention ; serious loss of blood may then occur, which will in turn induce an extreme degree of inertia. The uterus very generally requires stimulation at this period of labour. Sometimes post-partum inertia appears to be reflexly induced by a *full bladder*, and it may also without doubt be brought on by *nervous shock*. It is probable also that in some cases inertia is complicated by *deficient coagulability* of the blood preventing the formation of thrombi in the mouths of the sinuses, but, with the exception of some varieties of anæmia and the rare disease hæmophilia, we know nothing of the conditions which cause it. Since efficient retraction of the uterine muscle suffices of itself for the immediate arrest of the hæmorrhage, deficient coagulability of the blood is of secondary importance.

Incomplete Retraction.—Mechanical obstacles to proper retraction will occur when portions or the whole of the placenta or membranes have been retained in the uterus, and sometimes when there is a fibroid tumour in its wall. It does not necessarily imply want of activity of the uterine muscle.

Lacerations.—Those which affect the cervix and run up into the vaginal roof, so as to open the broad ligament to a greater or less extent, are the most formidable ; arteries of considerable size, and large venous plexuses, may be laid open, giving rise to free bleeding. Tears of the vulva and lower vaginal walls seldom cause severe hæmorrhage ; but it must be remembered that the large artery to the clitoris may be lacerated by a tear of the anterior part of the vulva, or the artery to the bulb by a deep lateral tear of the perineal body.

Diagnosis.—Post-partum hæmorrhage is usually external ; it may, however, be either partly or entirely concealed from distension of the uterus with blood-clot, or from the formation of a large broad-ligament hæmatoma. The condition of the uterus is an important indication of the cause of the bleeding, for if exhausted it is soft and flabby, with indistinct outlines ; but if the bleeding comes from a laceration the uterus will probably be found to be hard and well retracted. Uterine inertia and lacerations may, of course, exist in company ; it is necessary to remember this when hæmorrhage continues after proper retraction of the uterus has been secured. Free bleeding sometimes occurs from the apex of a deep perineal tear, but more commonly it comes from lacerations opening the vaginal roof.

A. **Treatment of Hæmorrhage from Inertia and from Incomplete Retraction.**—In normal labour the separation and expulsion of the placenta are neither accompanied nor followed by serious bleeding because the mouths of the torn maternal vessels are immediately closed by continuous retraction of the

uterine muscle; after the lapse of a few hours firm thrombi are formed in the mouths of the torn vessels, which plug them securely. Retraction is at first by far the more important, for thrombosis alone must be powerless to prevent hæmorrhage from large arteries until time has been allowed for the consolidation of the thrombi. The treatment of post-partum hæmorrhage from inertia must therefore be directed towards restoring

FIG. 292.—Expression of the Placenta by squeezing the Contracting Uterus and pushing it downwards and backwards into the Pelvis.

the suspended activity of the uterine muscle. When stimulation of the uterus is unsuccessful, bleeding can be temporarily arrested by compression of the organ, while time is allowed for the recovery of the functions of the muscle. In severe cases there is no time to lose, and it is of the utmost importance that the treatment adopted should be prompt and efficient.

It is a wise precaution to have ready at every labour everything for the treatment of post-partum hæmorrhage. On a

separate table should be placed a hypodermic syringe filled with pituitary extract or ergot, a douche-can with boiled rubber tubing and intra-uterine nozzle, antiseptic douche-lotion in a jug, sterile gloves in case the hand has to be introduced into the uterus, normal saline solution, apparatus and instruments for intravenous infusion, and sterile gauze for plugging. Boiling water and a large bowl of antiseptic lotion should be at hand. By thus having everything ready, unexpected hæmorrhage can be dealt with quickly and lives saved that unpreparedness might lose.

The following methods of stimulating the uterus should be employed consecutively, and in the order stated, until success is attained :—

A. *When the Placenta is still within the Uterus.* (1) *Manipulation of the Uterus per Abdomen.*—At the first sign of unusual hæmorrhage this method can be instantly applied ; it is therefore mentioned first. The uterus should be seized with both hands, rubbed and squeezed, firmly and continuously, until it is felt to respond by becoming harder as it is manipulated. If bleeding continues the placenta must without further loss of time be expressed by Crédé's method as described on p. 300 (Fig. 292).

(2) *Manual Removal of the Placenta.*—If the placenta cannot be expressed it must be removed by introducing the carefully sterilised and gloved hand into the uterus (see p. 468). Introduction of the hand to remove the placenta often has the effect of temporarily paralysing the uterus, and the completion of the operation should always be followed, without withdrawing the hand from the vagina, by bimanual compression until firm contraction is felt. When fairly contracted the uterus should be firmly squeezed in the hand in order to express all blood-clot from it. Firm retraction will not be obtained until the uterine cavity has been completely emptied. Even when the bleeding has apparently been controlled in this manner, gentle massage must be kept up for half an hour or more, as relaxation may recur. During or after the removal of the placenta, uterine stimulants should be administered. A copious antiseptic intra-uterine douche must always be given after manual removal of the placenta.

Continuation of hæmorrhage is treated according to the directions given under the next heading.

B. *Hæmorrhage occurring after Birth of the Placenta.* (1) *Manipulation of the Uterus per Abdomen.*—The uterus must be rubbed and squeezed firmly in order to empty it of clots and to stimulate it to contract.

(2) *Administration of Uterine Stimulants.*—A full dose of ergot may be given as soon as abdominal compression is begun. Its effect is produced most rapidly when administered by deep

intra-muscular injection, and the outer side of the thigh is a convenient spot for the purpose. The hypodermic dose is twenty minims of the injectio ergotinæ hypodermica. Even more useful than ergot under these conditions is pituitary extract (see p. 293), of which 1 c.c. of a 20 per cent. solution may be given by intra-muscular injection. These remedies take upwards of five minutes to produce their effect, and they should therefore be given as promptly as possible. Their chief value consists in *maintaining* uterine contraction after the hæmorrhage has been brought under control by other means.

(3) *Hot Douches.*—While abdominal compression is being practised the nurse in attendance can prepare a hot douche (temperature 120° F.) of boiled water, or some mild antiseptic such as lysol (a teaspoonful to a quart). This is a valuable supplement to abdominal manipulation, for it powerfully stimulates the retraction of the uterine muscle. Given through a long tube passed up to the fundus of the uterus, it is of course more effectual than when employed vaginally. The medical attendant cannot leave the uterus when there is serious bleeding in order to prepare the douche, and unless a reliable nurse is present, it had better be omitted at this stage. It is of the greatest service in increasing and maintaining retraction when the hæmorrhage has been to a great extent controlled by other means, but it is of little use to give it until the uterus has been fairly well emptied of blood-clot by compression or by the method next to be described.

(4) *Clearing out the Uterus.*—When the above methods fail to stop the hæmorrhage, the uterine cavity should be promptly cleared out with the fingers. The most careful sterilisation of the hands must be practised before this is done, and sterilised rubber gloves should be worn. The whole hand can be introduced into the vagina immediately after labour without causing the patient much pain, and two or three fingers can then be passed into the uterus, and, working in connection with the other hand upon the fundus, will readily clear out retained portions of the after-birth or blood-clot and at the same time powerfully excite the uterus to contract. Great care must be taken not to overlook small portions of adherent placenta. When the uterus has been emptied, a hot *intra-uterine* douche must be administered, the nozzle being passed and guided up to the fundus before the hand is withdrawn.

All but the most serious cases of hæmorrhage from inertia can be successfully dealt with by these means. In the worst cases, which are fortunately very rare, these methods may fail, and recourse must then be had to the following modes of treatment:

(5) *Bimanual Compression of the Uterus.*—This can im-

mediately be carried out if evacuation of the uterine cavity followed by an intra-uterine hot douche fails to induce proper retraction. The whole hand is passed into the vagina, and closed so that the fist lies beneath the uterus ; the other hand is laid upon the abdominal wall over the fundus, and the body of the uterus is firmly squeezed between the two hands (Fig. 293). In this way the placental site is directly compressed,

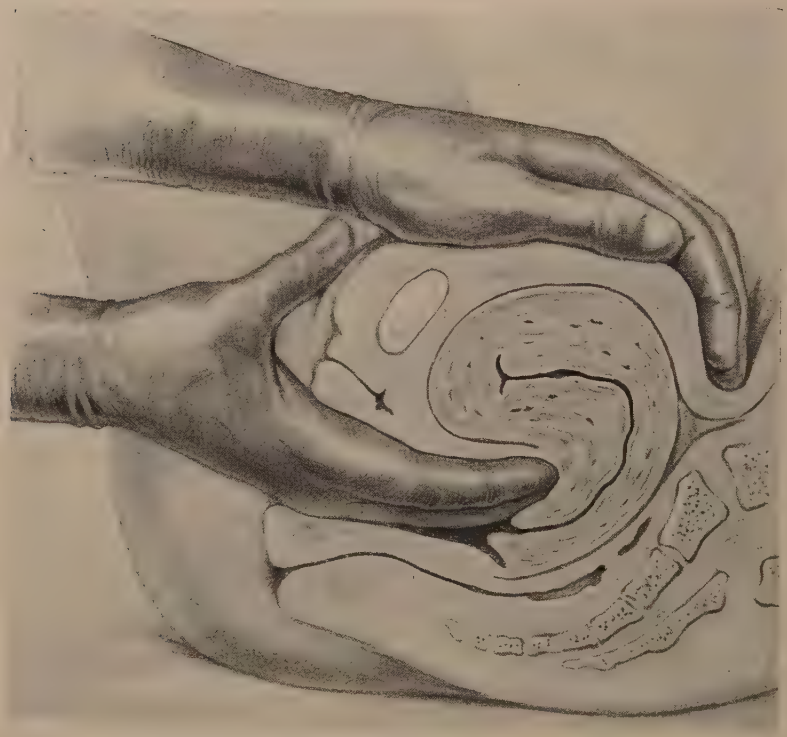


Fig. 293.—Bimanual Compression of Uterus.

and bleeding from the utero-placental vessels controlled. It may be necessary to keep up this form of compression for a prolonged period while other measures are adopted for restoring the patient, and so enabling the uterus to recover its activity. This method is most effectual and has superseded the old-time plan of directly compressing the abdominal aorta against the lumbar vertebræ ; pressure applied directly to the site of bleeding is, of course, much more effectual than compression of such a large vessel as the abdominal aorta.

(6) *Plugging the Uterine Cavity with Gauze.*—This may be done as an alternative to the last-named, or after bimanual compression has been applied without complete success. Long strips of gauze, 2 or 3 inches wide, and tied together, can be stuffed into the uterus, beginning at the fundus and tightly packing the whole organ down to the cervix. In plugging the uterus the cervix should be seized with a strong pair of volsellum forceps, with which it can be easily pulled down to the vulva; the gauze is then introduced directly into the uterus with a long probe or pair of forceps (Figs. 99 and 100). A very large quantity of gauze is required to fill the uterus. Domestic substitutes, such as strips of boiled linen, may be used in an emergency. The uterine plug acts mainly as a powerful excitant of uterine contractions; but it is quite possible to pack the organ so tightly as to control hæmorrhage by direct pressure. Bimanual compression is more useful than plugging, because it can be instantly applied, and requires no assistance or appliances. Plugging is further subject to the disadvantage that complete asepsis is so difficult to maintain when this method is employed. Bimanual compression is therefore in all circumstances the method of choice. The gauze should not be left in the uterus for more than twenty-four hours.

B. **Treatment of Hæmorrhage from Lacerations.**—Lacerations of the vulva and lower parts of the vaginal walls causing hæmorrhage should be immediately closed by suture, bleeding points being first ligatured. Deep lacerations of the cervix and vaginal roof are not easily closed by sutures, although with two pairs of strong forceps on the cervix the uterus can be drawn down a great deal; it may be very difficult to reach the highest point of the tear, and if the broad ligament has been opened bleeding points may be quite inaccessible. Accordingly many cases have been recorded where bleeding has continued after the laceration has been apparently sewn up. Two alternative methods to suture may be adopted: (1) bimanual compression; (2) plugging with gauze. *Bimanual compression* is described and practised by Fritsch. He places the closed fist against the perineum and presses the pelvic floor deeply into the pelvic outlet; owing to the relaxed and insensitive condition of the parts, this can easily be done. The uterus at the same time is pressed firmly downwards from the abdomen with the other hand, and thus the parts in the vicinity of the vaginal roof can be effectually compressed between the two hands, and the bleeding controlled. For *plugging* a laceration in the vaginal roof a speculum and a good light are required, and this method may therefore be very difficult to apply without adequate assistance.

C. **Restorative Treatment.**—Although the first indication in treatment is to arrest the bleeding, the general condition of the patient, in severe cases, also requires prompt attention, lest death from syncope should occur after the hæmorrhage has been controlled. While preparations are being made for the restorative measures described below, first aid in a serious case of hæmorrhage can be given by lowering the head and holding up the arms and legs in a vertical position, and if bandages are at hand, by bandaging the limbs from the feet or hands towards the trunk. In this way blood is conserved in the vital parts of the body. The best method of immediately counteracting the effects of severe loss of blood is the administration of normal saline solution in large quantities. Even when the patient's condition is not urgent, the injection of a pint or a pint and a half of this solution into the rectum is the best means of counteracting the collapse which always follows severe hæmorrhage. But if, during or after the bleeding, the patient is blanched, cold, unconscious, or if her pulse is over 140, transfusion of 2 pints of normal saline solution into the median basilic vein should be practised. For the most urgent cases intravenous transfusion alone will suffice, and this method may prove successful even when the patient appears to be almost dead. A useful alternative is to inject saline solution under strict antiseptic precautions into the subcutaneous tissues with a cannula, a piece of rubber tubing, and a funnel. The most suitable positions for the subcutaneous injection are (1) under the mammary glands, (2) under the skin of the posterior axillary wall, (3) under the skin of the abdominal walls. Salt should be dissolved in water in the proportion of one teaspoonful to a pint, and the solution boiled for ten minutes and then cooled. In the absence of the necessary apparatus for transfusion, the saline should be injected into the rectum ; not more than one pint can be given at a time, and the solution should be slowly introduced through a tube and funnel, or the bowel will reject it. The methods of *transfusion of blood* which have been employed in war surgery will no doubt in time become applicable for cases of obstetric hæmorrhage also. Great care is, however, required in the selection of the donor of blood, and this difficulty prevents general adoption of the method in the meantime.

The administration of cardiac stimulants by the mouth and by hypodermic injection is also of great importance, and the obstetric bag should always contain remedies of this kind. Camphor in oil, in sterile ampoules, is a useful remedy for hypodermic medication. Ether or brandy may also be administered in the same manner in doses of 20 to 30 minims. The hypodermic injection of an organic extract of the pituitary gland is the most powerful means we possess of temporarily raising blood-pressure, and its action as a stimulant of uterine

contraction has been already pointed out (p. 293). Elevating the foot of the bed for 18 inches may also assist the enfeebled circulation. The value of small doses of morphia in controlling restlessness after severe hæmorrhage should not be overlooked ; a dose of $\frac{1}{8}$ to $\frac{1}{6}$ of a grain, alone or in combination with atropine, will relieve pain or restlessness, and often induce a little sleep, which will be of great benefit to the patient.

Part V

THE PUERPERIUM

The Normal Puerperium

The puerperium is the period succeeding labour, during which certain processes take place the effect of which is to restore the genital organs approximately to the condition they were in before pregnancy. The features characteristic of nulliparity are never completely regained, for certain of the changes occurring in pregnancy, and the injuries received in labour, leave permanent alterations. The duration of the puerperal period may be stated as from six to eight weeks, but it is frequently longer than this. We do not possess any absolute clinical indication of the completion of the puerperal changes, but, as we shall presently see, the size of the uterus is the best guide.

Consideration of the normal puerperium comprises the following subjects :

(I.) The general physiology of the puerperium.
(II.) The involution of the genital organs.
(III.) The management of the puerperium, including lactation.

I. **The General Physiology of the Puerperium.**—At the close of a normal labour the *general condition* of the patient is merely that of physical fatigue. The pulse is full and moderately slow —70 to 80 beats per minute ; the temperature is usually subnormal. Not infrequently a slight shivering, marked by muscular tremor and chattering of the teeth, occurs, and may last from ten to fifteen minutes ; it is unaccompanied by elevation of temperature or pulse-rate, and is to be regarded as a symptom of slight surgical shock. Immediately after a prolonged labour the patient may show signs of well-marked ' obstetric exhaustion,' with a temperature of 101° F. or higher ; and when severe hæmorrhage has occurred there will, of course, be shock and pallor, with a rapid pulse and a lowered temperature.

During the first twenty-four hours the temperature very commonly rises one or two degrees, even after a normal labour, and 100° to 101° F. may in this way be recorded without any unfavourable accompaniments. This is especially common in primiparæ. The rise of temperature is to be regarded as due

to the '*reaction*' from the severe muscular fatigue of labour, in all probability a mild toxæmia from absorption of waste products from excessive muscular effort; it is never prolonged, and disappears entirely by the second day (Fig. 294). After the first twenty-four hours the temperature shows a diurnal variation of about a half to one degree, and in normal cases it often does not rise above 99·4 °F., and may indeed be subnormal. In many cases, however, which otherwise run a normal course, the evening temperature for the first few days may reach 99·8° or 100° F. Instability of the body temperature is one of the characteristics of the puerperium; consequently varia-

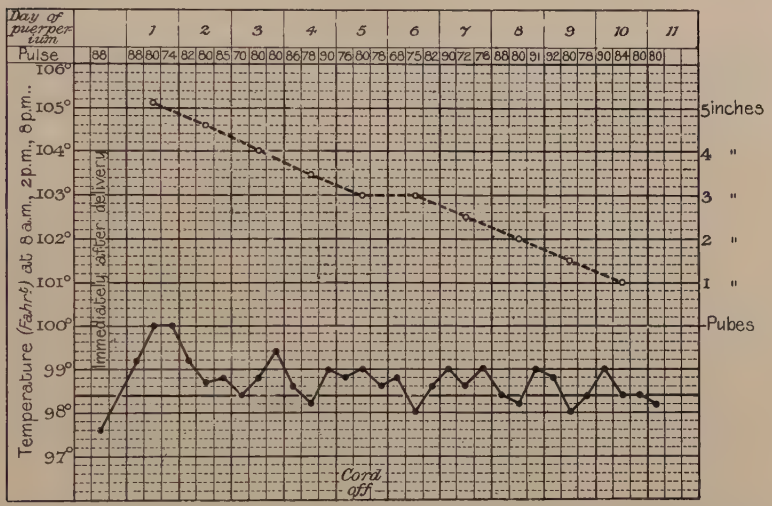


FIG. 294.—Chart of a Normal Puerperium, showing Reactionary Rise of Temperature on the First Day. (Queen Charlotte's Hospital.)

NOTE.—The interrupted line indicates the height of the fundus above the upper border of the symphysis pubis.

tions occur from causes too trivial to produce any effect on health. The temperature should be taken at least three times daily, convenient hours being 8 A.M., 2 P.M., 8 P.M.; if taken only morning and evening, an evanescent rise may escape notice. Temporary elevation of the temperature to 100° to 102° F. may occur during the first puerperal week from a number of slight causes, such as errors in diet, gastro-intestinal disturbances, excitement or other nervous disturbance, or mammary discomfort at the beginning of lactation (Fig. 295). It appears certain that gastro-intestinal disturbances are responsible for many cases of slight fever during the first week. Hospital patients admitted when labour has advanced too far to allow time for the usual preparation by an aperient naturally

show this form of pyrexia more often than others who have been properly prepared. In many other cases the administration of a purgative is immediately successful in bringing down the temperature, although no other treatment is adopted. Fever from excitement is the most evanescent of all, and lasts only a few hours. The fourth day is the time when the breasts become most severely distended, and rise of temperature from this cause may be met with. Primiparæ are the more liable to it, but when suitably treated the fever seldom lasts more than twenty-four hours. Pyrexia from any of these causes does not in any way disturb the general course of the puerperium.

The significance of a rise of temperature in the puerperium

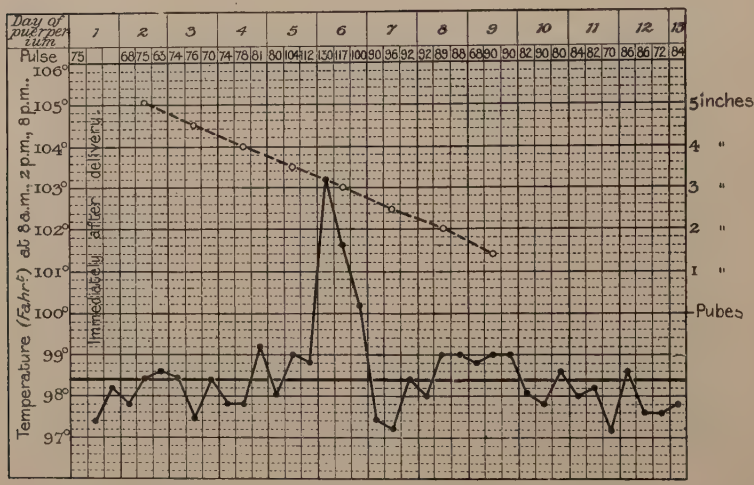


FIG. 295.—The Evanescent Rise of Temperature on the Sixth Day was due to Nervous Excitement. (Queen Charlotte's Hospital.)

is accordingly often obscure at first. Fever lasting for twenty-four hours or more is a certain indication of 'morbidity,' but evanescent rises of temperature do not necessarily indicate abnormal developments. Various standards of 'morbidity' are in use in other countries, but in this country it has been generally agreed, upon the suggestion of a committee of the British Medical Association, to regard as 'morbid' all cases in which the temperature reaches 100° F., or over, on two occasions between the second and eighth days. This period will not include the *reactionary* rise just referred to. 'Fever,' during the puerperium, as thus defined, is due in the great majority of instances to septic infection, and unless some other cause can be determined definitely, such cases must be regarded and treated

as septic. There are but few exceptions to the general rule that an aseptic puerperium is also afebrile ; it is, however, obvious that febrile affections, quite independent of the puerperium, may attack a lying-in woman, although no septic infection has occurred.

The *pulse-rate* is usually slow (60 to 70) for the first twenty-four to forty-eight hours, and if a reactionary rise of temperature occurs, the pulse-rate does not rise with the temperature; it may even fall as the temperature rises (Fig. 294). After the

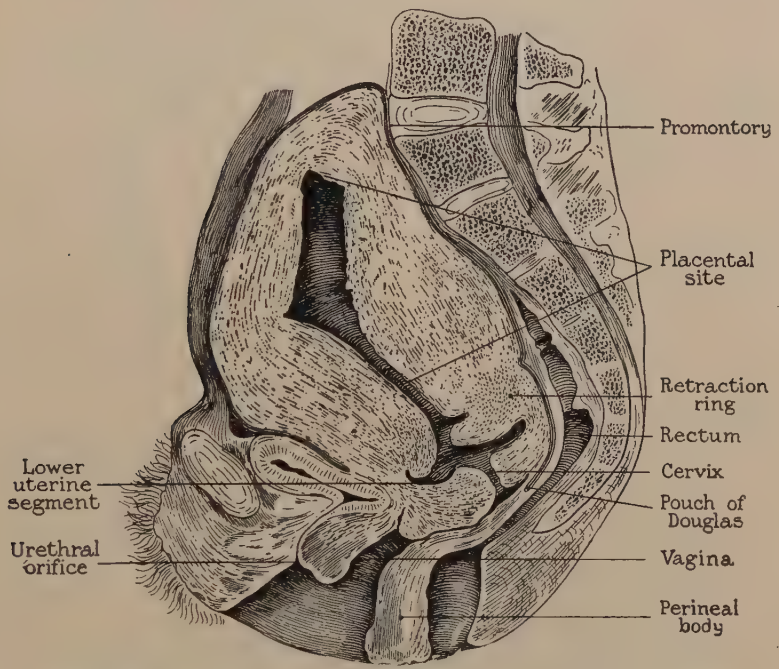


FIG. 296.—Frozen Section of the Pelvis of a Woman who died immediately after Delivery. (Barbour.)

third day the rate is about normal, varying slightly in correspondence with the temperature. In patients anæmic and debilitated from hæmorrhage the pulse-rate will remain abnormally rapid for several days. In the absence of such causes, a pulse-rate continuously over 90 is always disquieting. When fever is accompanied by a disproportionately rapid pulse, the cause is usually sepsis.

The Excretions.—Great variations occur in the amount of *urine* excreted during the early days of the puerperium. There is, however, as a rule, well-marked diuresis for the first two days ; the amount then gradually falls until it reaches the normal

level. Sugar is normally present in the urine after the mammary glands have become active ; it is lactose, not glucose, and is derived, not from the liver, but from the mammary glands. Peptones are present in small amount from the second to the tenth day, and observers are agreed in attributing them to the involution changes going on in the uterine muscle. Traces of albumen and acetone are frequently found, and the percentages of urea, phosphates, and sulphates are reduced. The act of urination is at first somewhat painful, and retention of urine may occur either from spasm of the sphincter from 'nervousness,' or from paresis of the muscular walls of the bladder. The former condition, when extensive laceration of the perineum has occurred, is often met with, and is only temporary ; 'nervous' retention may occur apart from injury, and sometimes persists until the patient can get up.

The *skin* acts freely, and for the first few days the *bowels* are usually constipated.

Blood.—The deficiency in red cells and hæmoglobin, which is natural in pregnancy, is rapidly made up during the ten days following labour. The leucocytosis, also natural to pregnancy, rapidly disappears during the same period, the number of white corpuscles falling from about 21,000 per c.mm. to 10,000 per c.mm. (Henderson). A rapid rise in the number of leucocytes indicates the onset of some septic or inflammatory condition.

The *digestive functions* are, as a rule, depressed during the first two or three days, there is little or no appetite, and in consequence only fluid and easily digestible solid food can be taken. Robust women may show no diminution of appetite or digestive power.

Body-weight.—During the first ten days there is a slight progressive loss of weight, which is more marked in non-nursing than in nursing women.

II. **The Process of Involution.**—The *uterus* diminishes rapidly in size for the first ten days, and then more slowly, the whole process requiring six to eight weeks for its completion. According to Whitridge Williams, the uterus loses 50 per cent. of its weight during the first week of the puerperium. Immediately after labour the uterus weighs two pounds, and at the end of the puerperium it has returned to its normal weight of two ounces ; during the first week of the puerperium it actually loses one pound, and during the second week half a pound ; during the remaining four weeks the loss in weight is more gradual. The diminution in size can be followed by abdominal examination, and forms a very important clinical index of the course and progress of puerperal involution generally. The condition of the uterus immediately after delivery is shown in the frozen section seen in Figs. 296 and 297. It fills the pelvic cavity, and at its highest point rises slightly above the level

of the sacral promontory ; the two sections differentiated from each other during labour—viz., the body and the lower seg-

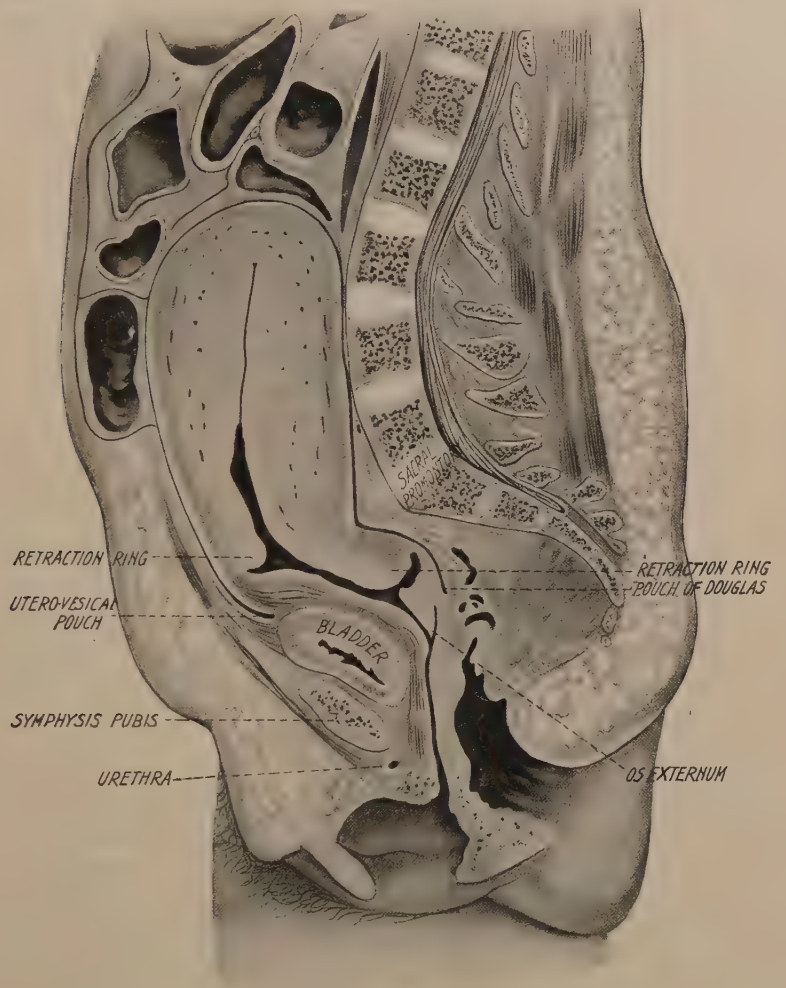


FIG. 297.—The Uterus immediately after Delivery, also from a Frozen Section. The position of the lower segment is clearly defined by the retraction ring and the thinness of the wall immediately below it. The pelvis is contracted, and the uterus is much higher than normal. (Barbour.)

ment—are still distinct, and the cervix is once more distinguishable from the latter. In section the wall varies in thick-

ness, measuring from $1\frac{1}{2}$ to 2 inches (4—5 cm.) where it is thickest to less than $\frac{1}{2}$ inch in the lower segment, and the uterine cavity is almost obliterated by apposition of the anterior and posterior walls. Its total length is $7\frac{7}{8}$ inches (20 cm.); the length of its cavity is $6\frac{1}{4}$ inches (15·5 cm.). Clinically the uterus immediately after delivery forms a large, firm pyriform swelling in the lower abdomen rising up to the level of the umbilicus, freely movable, and undergoing slow variations in consistence. Accurate study of the rate at which the uterus diminishes in size can be made only upon the cadaver, and Webster has collated the following table from observations of this kind :

Date.	Whole Uterus.	Uterine Cavity.
Immediately after delivery	$7\frac{7}{8}$ in. long	$6\frac{1}{4}$ in. long.
2nd day	$7\frac{1}{8}$,, ,,	$6\frac{1}{4}$,, ,,
3rd ,,	$6\frac{3}{8}$,, ,,	$5\frac{5}{8}$,, ,,
6th ,,	$5\frac{1}{8}$,, ,,	$4\frac{5}{8}$,, ,,
15th ,,	$3\frac{3}{4}$,, ,,	$3\frac{3}{8}$,, ,,

From this it will be seen that during the first week the uterus diminishes much more rapidly than during the second; that the total length diminishes more rapidly than the length of the cavity owing to the rapid reduction in the thickness and bulk of the walls; and that on the fifteenth day it is still very considerably larger than the normal organ (cavity $2\frac{1}{2}$ inches, 6 cm.). Fig. 298 shows that on the third day the lower uterine segment is no longer distinguishable from the rest of the body. Fig. 300 shows great reduction in size on the fifth day; the walls of the cervix are much thinner, and numerous large solid thrombi are seen at the placental site.

The rate of involution varies considerably in different persons, even when the conditions appear normal. The measurements given above must therefore be regarded as approximate, not exact.

In making clinical observations attention is chiefly directed to the height of the fundus above the symphysis pubis. The results of such observations necessarily differ from post-mortem measurements of frozen sections. But it must be recollected that the position of the uterus is largely influenced by the condition of the bladder, and to some extent by that of the rectum. When the bladder is full the whole uterus is elevated, and usually displaced to one or other side, more commonly the right, the hypogastric region being occupied by a soft elastic swelling, dull on percussion, and readily recognisable as the bladder. Consequently, if daily measurements are made, they should always be made immediately after the bladder and the

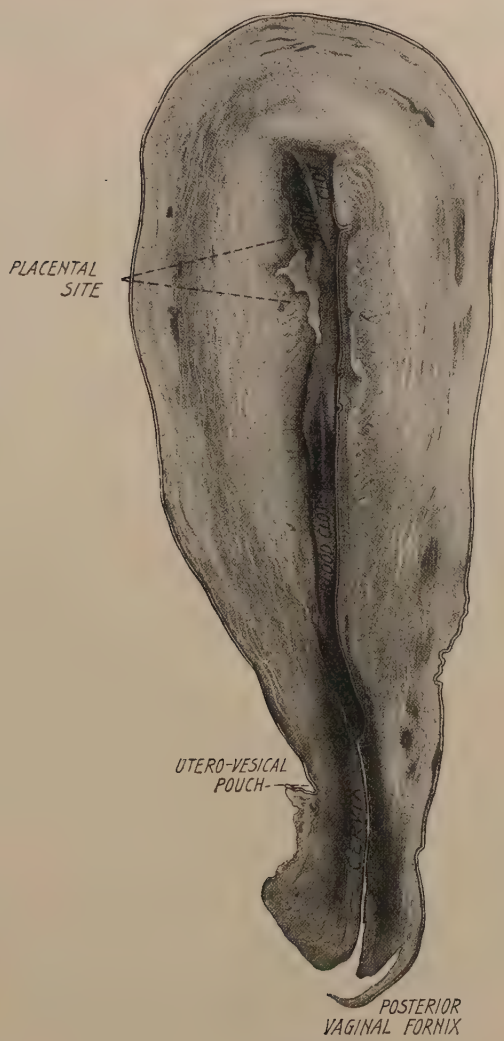


FIG. 298.—Uterus 40 Hours after Normal Delivery. Total length 7½ inches, length of cavity 6½ inches. The blood-clot lying in the cavity springs from the ragged area on the anterior wall representing the placental site. The position of the lower segment cannot be made out, and the retraction ring has disappeared. (Barbour.)

bowels have been evacuated, so as to ensure uniformity. From careful measurements made by Griffith and Stevens at Queen

Charlotte's Hospital, it appears that the average height of the fundus on the first day is $5\frac{1}{4}$ inches ; by the sixth day it has

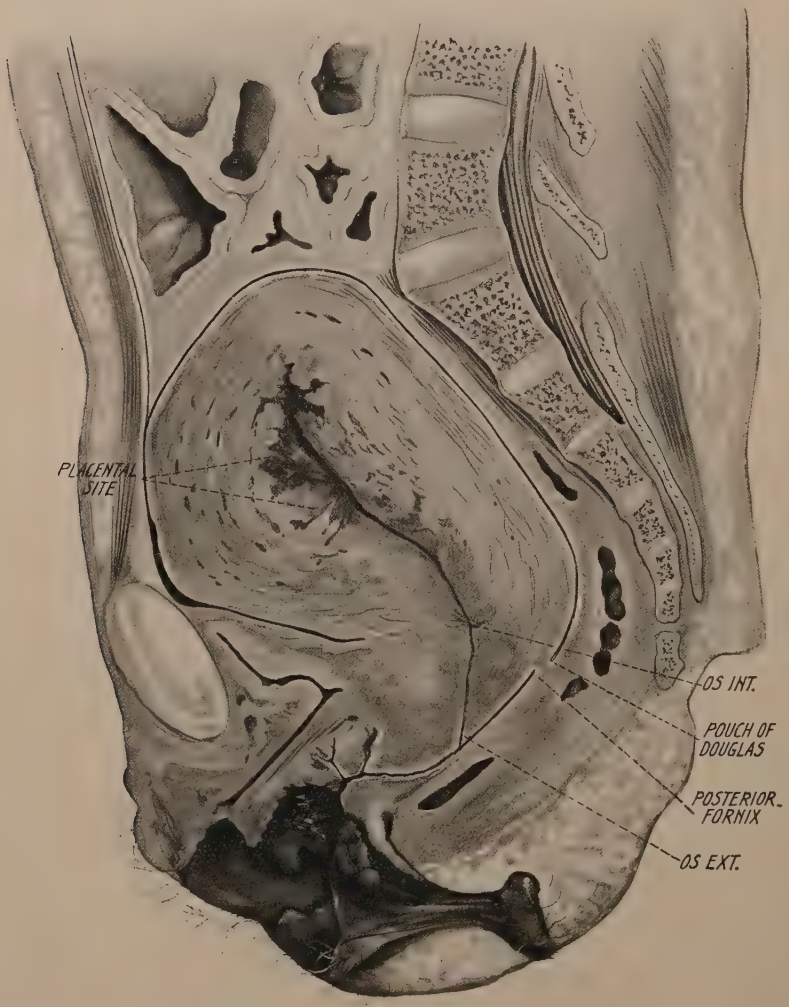


FIG. 299.—Uterus Two and a Half Days after Delivery. The top of the fundus reaches three inches above the pubes. The placental site is at the fundus. (Barbour.)

fallen on an average to $3\frac{1}{4}$ inches, and by the twelfth day to $1\frac{3}{4}$ inches above the pubes. After the fourteenth day the fundus, as a rule, sinks below the level of the pubes—*i.e.*, into the pelvic cavity ; but not infrequently this does not occur

until the end of the third week. The rate of involution, estimated in this way, is about the same in primiparæ and multiparæ, but in the latter the uterus is rather larger throughout. Roughly speaking, it may therefore be said that at the end of the first week the fundus should be half-way between the pubes and the umbilicus, and at the end of the second week just palpable above the level of the pubes.

The importance of systematically observing the involution of the uterus, as a guide to the normal progress of the puer-

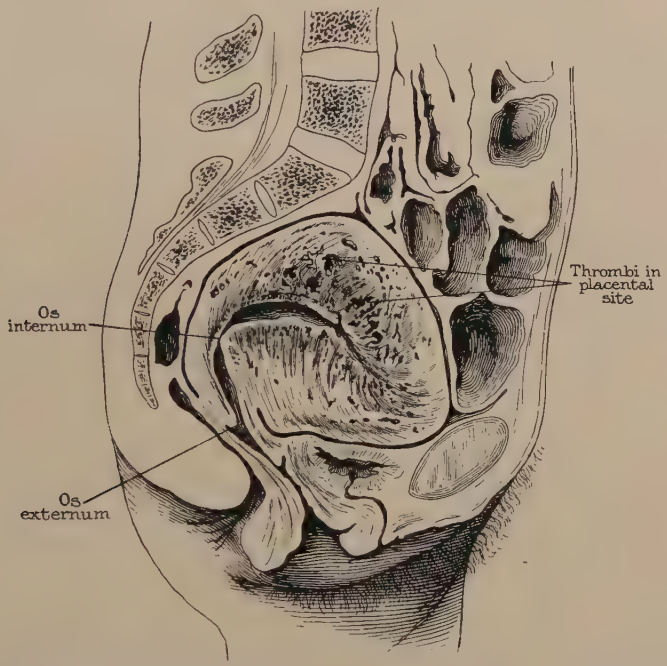


FIG. 300.—Frozen Section of the Pelvis of a Woman who died five days after Delivery. (Bumm.)

perium, cannot be over-estimated. When recorded upon the temperature-chart in the manner indicated in Figs. 294 and 295, it supplies, along with the temperature-curve, important information as to the general progress of the patient. There is a number of conditions which unfavourably influence the rate of involution of the uterus. Thus, in multiparæ, it is found that after five or six pregnancies have occurred involution requires appreciably longer than the average. When the uterus has been unusually large, as in hydramnios or twins, when there has been severe ante- or post-partum hæmorrhage, and when the woman does not suckle her child, involution is delayed.

The retention of tissue in the uterine cavity, especially if it should become infected, delays involution, but not all varieties of uterine infection produce this effect (see p. 509).

Structural Changes in the Uterus.—It was formerly believed that involution was dependent on a fatty degeneration of the muscle fibres and that large numbers of them completely disappeared. It is now known that neither of these changes occurs. Very careful measurements of the fibres of the uterine muscle during the puerperium have been made by Sänger; he found that in length they diminish rapidly and at a fairly uniform rate, until at the fifth week they are actually shorter than in the non-pregnant organ; in breadth they increase during the first few hours by retraction, and then steadily diminish until at the fifth week they are only a trifle broader than before pregnancy. It is now known that involution is effected by *autolysis* of the muscle fibres, whereby their protoplasm is broken down by proteolytic ferments into soluble end-products which are removed by the blood-stream. In the puerperal uterus the activity of the intra-cellular ferments is greatly increased, and their action is no doubt further aided by the anæmic state of the well-retracted uterus. In this connection it will be recollected that peptones are present in the urine of puerperal women, and that there is a great increase in the total quantity of nitrogen in the urine during the first few days of the puerperium.

The Uterine Vessels.—The involution changes in the vessels have been studied by Goodall. This observer has shown that to a great extent the old vessels first become obliterated by thrombosis and then undergo degenerative changes and disappear, while new vessels are formed to replace them. Further he has demonstrated the appearance of new vessels of small size in the organising clot formed in the lumen of the obliterated vessels. The walls of the old vessels undergo gradual degeneration and absorption, new connective tissue growing in from the uterine wall to replace them and support the small newly formed vessel. This change occurs alike in arteries and veins, and the new vessels are complete in structure, consisting of the usual three coats. Absorption of the walls of the old vessels is often incomplete, and a process of degeneration occurs, converting the remains into 'elastin,' a substance with characteristic staining reactions. The recognition of scattered areas of this substance is therefore equivalent to a diagnosis of parity, and in the condition known as *sub-involution* (imperfect involution) elastin is present in excess (Fletcher Shaw).

The Uterine Mucosa.—A considerable portion of the cavernous layer of the decidua remains attached to the uterine wall; but here and there bare patches of the muscular wall may be seen. The membrane is furrowed and folded by the retraction

of the subjacent muscle, and soon becomes covered with a layer of fibrin. In seven to eight weeks the mucous membrane is entirely re-formed by proliferation of the remaining epithelial and connective-tissue elements. When the puerperal uterus of the first week is laid open, the placental site may be readily distinguished, as its surface is slightly elevated and nodular, the irregularities being chiefly caused by the extensive thrombosis which has occurred in the sub-placental sinuses (Figs. 299 and 300). Outside the placental site the wall is smooth and uniform.

The Lochial Discharge.—This is the discharge which escapes from the genital canal during the first two to three weeks of the puerperium. For the first twenty-four hours it consists of blood, mostly fluid, but frequently containing small clots ; it then becomes thinner, though still of the colour of recent blood. About the third or fourth day it becomes brownish ; by the end of the first week it is yellowish or greenish ; and then gradually loses all colour, being white and turbid until its final disappearance. Besides red blood cells and fibrin, it contains leucocytes, decidual *débris*, vaginal epithelium, mucus corpuscles, and in the later stages leucocytes. Peptones and cholesterin crystals have also been found in it. It is a common observation that when the uterine cavity has been douched after labour the amount of lochial discharge is always unusually small.

Throughout a normal afebrile puerperium, in the *uterus* the lochia are alkaline in reaction, and usually have a faint sickly odour ; in the *vagina* they become acid, and after the first few days usually contain numerous non-pathogenic bacteria. The bacterial condition of the lochia has been the subject of many contradictory observations, and certain points are still unsettled. It appears certain, however, that in the vagina the lochial discharge does not remain sterile for more than twenty-four hours, while in the cervix bacteria can always be found after the second or third day. The conditions in the body of the uterus are much more difficult to determine owing to the technical difficulty of obtaining lochia from the uterine cavity without contamination from the cervix, and the results obtained have not been uniform. Foulerton and Bonney have shown that with proper technique no bacterial growth can be obtained from the uterus in a large proportion of normal cases, but their series was too small to permit of percentages being calculated. It is possible that the *positive* results obtained in a large proportion of cases by others have been due to faults of technique permitting of cervical contamination. But it is improbable that in the normal puerperium the uterine cavity remains sterile for more than the first day or two. Under morbid conditions the lochia may be suddenly suppressed, or may become fœtid from infection, or may be altered by fresh

hæmorrhage. When involution is delayed, they may persist longer than usual, although not abnormal in characters. The source of the lochial discharge is mainly the uterine cavity, but cervical, vaginal, and vulval lacerations also contribute to it to some extent.

After-pains.—In multiparæ the normal puerperium is usually accompanied for the first one or two days by painful contractions of the uterus, which are known as after-pains. These, when *slight,* are probably of service in maintaining the necessary close retraction of the uterine wall, and they require no treatment. *Severe* after-pains are usually due to the presence of some foreign body, such as a blood-clot or a piece of membrane or placenta. From imperfect retraction blood-clot may form in the uterine cavity even after it has been completely emptied at the end of the third stage ; this is much more likely to occur with a multipara than with a primipara, for retraction is usually adequate in primiparæ. But when the uterus is not empty, after-pains may be met with in a primipara just as in a multipara. They should be treated by stimulating the uterus to expel the foreign body. This may be done by giving a teaspoonful of liquid extract of ergot every four hours, a dose of castor oil, and by massaging the uterus *per abdomen.* The expulsion of a blood-clot usually follows in a few hours, revealing the cause of the trouble.

Severe after-pains sometimes occur with a completely retracted and empty uterus : we do not know what may be the exciting cause of the painful contractions in such cases. Pains of this character can usually be cured by administering a dose of antipyrin (10 grains), which should be given with a stimulant, such as 20 to 30 drops of sp. ammoniæ aromat.

III. **Management of the Puerperium.**—There are three objects to be kept in view in the management of the lying-in woman : (1) to maintain asepsis in the genital canal ; (2) to enforce a sufficient period of rest ; (3) to take proper care of the breasts during lactation.

(1) *Asepsis.*—If the antiseptic precautions observed during labour have been successful, the genital canal should be sterile at the beginning of the puerperium ; and the principal care of doctor and nurse is to prevent infection from reaching it. The greatest possible care must accordingly be taken of the vulva. The lochial discharge should be received upon sterilised pads of absorbent wool or gauze : the pads should be removed and burned as soon as they become soiled. During the first three or four days the vulva should be frequently swabbed with a solution of lysol (℥j to Ojj). It is essential that the nurse's hands and all the appliances used, such as catheters and vaginal nozzles, should be as carefully sterilised during the puerperium as during labour.

The posture in bed of the puerperal woman is of importance. After a normal labour she should lie in a semi-sitting posture, supported with pillows or a bed rest and with a fixed bolster under the knees. The lochial discharge will then escape freely, whereas in the recumbent posture the lochia collects and stagnates in the vagina, and may decompose. Free drainage is prophylactic against infection, and if the labour has been an operative one, with increased risks of infection, the high Fowler position should be adopted from the first unless contra-indicated by exhaustion or anæmia.

Vaginal douching is unnecessary when the puerperium runs a normal course. The aim of management should be to preserve the genital tract from contamination, rather than to endeavour to destroy organisms which may have gained access to it. No amount of vaginal douching can compensate, for instance, for careless treatment of the vulva. Vaginal douching, in addition to being unnecessary, may become positively dangerous, when carried out carelessly or by untrained persons, by introducing into the vagina organisms which would not otherwise obtain access to it. Routine vaginal douching has accordingly been universally abandoned. Decomposition of the lochia, indicated by fœtor, is the most frequent indication for the douche in an afebrile puerperium, and this is seldom met with before the end of the first week. Hot douching may also be required for the control of puerperal hæmorrhage, or to promote the expulsion of blood-clot or membrane retained in the uterus in the early days of the puerperium.

Antiseptics which may be employed for vaginal douching are lysol (℥j to Oj), or a solution of iodine (℥j of tinct. iodi to Oj of water). When douching the *uterus* in the early puerperium the same solutions may be employed in one-half the strength used for the vagina. Although these solutions are useful for douching, in sterilising the skin mercurial solutions are much more efficient than any others. It must be remembered that by the indiscriminate use of mercurial douches acute mercurial poisoning may be set up. The symptoms of mercurial poisoning from absorption are the same as those produced when the poison is taken bythe mouth—viz.,vomiting,diarrhœa, salivation, acute gingivitis.

A well-ventilated room free from risk of contamination from faulty drain-pipes, and clean fresh bed-linen and bed-garments, are valuable aids to the maintenance of asepsis.

(2) *Rest.*—Rest in bed, but not necessarily in the horizontal position, should be maintained until the uterus has sunk below the symphysis pubis and the lochial discharge has become colourless. When ordinary avocations are resumed with the uterus as large as it is on the tenth day of the puerperium, it is clear that there must be liability to prolapse, retroversion, and

sub-involution. The poor habitually neglect this precaution, but there is little doubt that they suffer in consequence, the greater frequency of prolapse in hospital patients than in the well-to-do being chiefly attributable to this cause. After the first twenty-four hours the patient should be propped up with pillows or a bed-rest, and this position is of advantage in promoting the escape of the lochia. Light and nourishing food, both solid and fluid, may be given freely during the first two days; an aperient should be administered on the evening of the second day, and after this ordinary food may be taken. The action of the bowels is usually sluggish while the patient is confined to bed, and a daily mild aperient may be required, or an enema if the former will not suffice. The condition of the bladder must be carefully watched during the first two days; if retention occurs resort should not be had to the catheter until means of procuring spontaneous evacuation have been tried. The strictest antiseptic precautions are required for this simple procedure. Occasionally the bladder is imperfectly evacuated by the natural efforts and becomes gradually over-distended, causing great discomfort. This condition will be recognised by careful abdominal examination. Emotion and excitement may produce alarming rises of temperature in lying-in women; therefore, in private practice, patients should be kept almost isolated for the first few days. Sleep almost always comes naturally to a lying-in woman, but hypnotic drugs should be given without hesitation if sleep is absent or insufficient, for sleeplessness may be a prelude to serious mental complications.

For patients who are able to afford it, general massage by a skilled person may be used with great benefit after the first week. This aids digestion and promotes the natural action of the bowels, improves the general condition, which is apt to suffer from muscular inaction, and by improving the tone and condition of the abdominal muscles helps to restore these structures, which have necessarily suffered from stretching in pregnancy. To women who set store upon their 'figure' this is also a point of some æsthetic importance. Permanent loss of power of the abdominal muscles is in all probability an important predisposing cause of displacement of the pelvic and abdominal viscera. In all cases a bi-manual examination of the uterus should be made before the patient gets up; backward displacement can be readily corrected at this time by manipulation with the fingers, and a ring or Hodge pessary can be at once introduced and worn for a few weeks. All lacerations should also be inspected at the same time; unless infected, they will heal in seven to ten days, but the patient should not be allowed to get up with an unhealed perineal laceration.

The 'Rational' Puerperium.—Under this somewhat misleading name an attempt has been made to show that it is inadvisable to keep women in bed for more than two days after labour, and that they will be benefited by being encouraged to get up, and sit up or walk about, whenever the obstetric conditions are in all respects normal. The main reasons assigned for this innovation are that pregnancy and labour are not morbid but physiological processes, and that primitive or uncivilised woman does not observe a lying-in period and apparently does not require it. The name given to this method of management is unfortunate and regrettable, inasmuch as it introduces prejudice by implying that the alternative method is irrational. The reasons assigned for regarding the method as 'rational' hardly deserve consideration, for if pregnancy and labour are not morbid processes they are attended by greater risks and may be followed by more serious sequels than many recognised diseases. The example of the uncivilised woman, also, is not in all respects to be enjoined upon others; she does not practise the use of antiseptics in labour, but we do not for that reason regard them as irrational. The advocates of this form of management of the puerperium have undoubtedly shown that no *immediate* ill effects follow from allowing a lying-in woman to get up and walk about at an earlier period than has usually been thought desirable. Whether these women suffer more than others from the remote ill effects of child-bearing has not yet been shown.

(3) *The Process of Lactation.*—By lactation is meant the establishment of functional activity in the mammary glands. This subject is best considered in connection with the management of the infant (p. 538).

The Signs of Recent Delivery.—In cases of alleged concealment of birth, or of criminal abortion, it may be necessary to look for evidence in the form of confirmatory physical signs, and it will therefore be useful to summarise these by way of completing the consideration of the puerperium.

After Delivery at or near Term.—The abdominal walls are very lax, and the skin is marked with recent striæ; the uterus will be large and the fundus easily felt *per abdomen* during the first ten days; the breasts will contain abundant secretion, except in rare instances when the breasts never secrete freely. At the vulva the lax condition of the ostium vaginæ will be noticed, and the presence of recent partly healed lacerations. It should be recollected that in a multipara only recent injuries can be regarded as evidence. The lochial discharge will be present, corresponding in character to the puerperal date. The cervix will be soft and patulous: *i.e.*, the index finger can readily pass the internal os during the first ten days; lacerations, recent and soft, or old and cicatricial, will be met with. The

uterine body will be enlarged symmetrically, and of softish consistence.

After Abortion.—There may be no signs in the abdomen or mammæ ; there may be no vulval lacerations ; there will probably be softening of the cervix and more or less enlargement of the uterus with a lochial discharge. These latter signs are not conclusive in themselves, but if taken together, and especially if associated with signs of traumatism, such as recent laceration of the cervix or vaginal roof, such as might be caused by the performance of an unskilled operation, the evidence is of great value.

Puerperal Infection

Under the term ' puerperal infection ' is included a series of febrile disorders of the lying-in period due to the active development of certain pathogenic bacteria, which enter the body through wounds of the genital tract ; in the great majority of cases these organisms are introduced from without, but in a few instances they may have been present in the genital tract at the time of labour. It must be borne in mind that puerperal infection may occur after abortion as well as after labour.

All controversy as to the nature of ' puerperal fever,' ' childbed fever,' or ' milk fever ' has long since been set at rest, and we now know it to be due to sepsis or wound-infection. To a Scotch physician, Robert Gordon, of Aberdeen, belongs the credit of first publicly declaring his belief that puerperal fever was infectious and could be carried from patient to patient by the doctor or the nurse (1795). About 1840 to 1843 Oliver Wendell Holmes in the United States, and Semmelweiss in Vienna, independently recognised that puerperal fever could also be set up by infection carried from the dead-house. To Semmelweiss has been now adjudged the chief credit of this important discovery ; but his work was to a great extent neglected for thirty years, when the discoveries of Lister placed the matter upon a scientific basis by showing that bacteria were the agents by which surgical infection was produced and propagated. Doléris, working with Pasteur, first showed in 1880 that streptococci could be found in the uterus in cases of ' puerperal fever,' thus definitely bringing the disease into the class of ' wound-infections,' and demonstrating its close relation to suppurative processes.

The combined work of these observers has resulted in the practical disappearance of puerperal infection from lying-in hospitals, and has undoubtedly been the means of saving the lives of innumerable lying-in women. In the time of Semmelweiss outbreaks of puerperal infection occurred from time to time in maternity hospitals, sometimes attended by the

appalling mortality of 60 to 75 per cent. ; and seldom did the mortality from puerperal fever in these institutions fall below 10 per cent. At the present time the mortality from puerperal fever in such hospitals is about 1 to 2 per 1,000, and epidemics are unknown. No more striking instance than this exists of the value of Lister's principles. But puerperal infection still occurs, although not in epidemic form, and the returns of the Registrar-General show that puerperal infection causes far more deaths than any other complication of pregnancy and childbirth and, even at the present time, accounts for more than one-third of the total maternal mortality. His returns also show that although in recent years there has been a decline in the death rate from puerperal infection, the decline has been a disappointingly small one, especially in consideration of the increase in our knowledge of the causes and prevention of infection in general.

The following table for England and Wales will make these points clear. Only a few years between 1900 and 1923 have been selected ; it will be noticed that except for a rise in 1920 (there was a similar rise in 1919), there has been a steady though small decline since 1900.

Year.	Number of maternal deaths from all causes.	Proportion of deaths per 1,000 live births.	Proportion of deaths by sepsis per 1,000 live births.	Proportion of deaths by sepsis to total deaths.
				Per cent.
1900	4,455	4·81	2·18	46
1903	3,857	4·07	1·76	43
1906	3,757	4·02	1·75	44
1909	3,379	3·70	1·56	42
1912	3,299	3·78	1·47	40
1915	3,210	3·94	1·56	40
1918	2,353	3·55	1·35	38
1920	3,942	4·12	1·87	45
1921	3,145	3·71	1·46	39
1922	2,971	3·58	1·46	41
1923	2,732	3·60	1·30	36

A. **Causation.**—There are four factors to be considered in the causation of puerperal infection : (I.) The bacteria. (II.) The sites of infection. (III.) The sources of infection. (IV.) The conditions which predispose to infection.

I. **The Bacteria.**—The infecting bacteria are of a similar nature to those found in other septic wounds, and may be conveniently divided into three groups : (a) pyogenic organisms, (b) anaerobic putrefactive (saprophytic) organisms, (c) certain specific organisms.

(a) *Pyogenic Organisms.*—These are the common organisms

of suppuration and sepsis ; those which have been found in cases of puerperal infection are (1) the *Streptococcus pyogenes*, (2) the *Staphylococcus pyogenes*, (3) the *Bacillus coli communis*, and, though rarely, (4) the *Bacillus pyocyaneus*. By far the most important member of this group is the streptococcus, which is present in pure culture in 40 to 50 per cent. of cases of puerperal infection (Lea). In a series of nine-six severe cases Western found streptococci in 80 per cent., and of these 76 per cent. were pure cultures. Many different varieties of streptococcus are known, and that concerned in puerperal sepsis does not appear to be a specific variety, although some attempts have been made to show that it pursues specific cultural reactions. In addition, it is frequently present in association with other organisms, one of the most frequent associates being the *Bacillus coli*. The most severe of all cases of puerperal infections are due to the streptococcus, either alone or in company with the *Bacillus coli*. Streptococci occur in a variety of degrees of virulence, and there are many varying types ; the hæmolytic type is the most virulent. Some are saprophytic only, or even apparently non-pathogenic. Streptococci may be found in the skin of the vulva and in the vaginal secretions of healthy pregnant and non-pregnant women, but are usually of low potential virulence.

(b) *Saprophytic bacteria* are organisms which grow and multiply in dead tissues, causing the phenomena of putrefaction ; they do not invade the body generally, and they tend to disappear spontaneously when the pabulum upon which they flourish is exhausted ; the general effects which they produce are due to the absorption into the circulation of the *toxins* which result from their growth and action. These bacteria are mostly anaerobic bacilli and cocci, but their varieties are very numerous ; the *Bacillus proteus vulgaris*, the *Bacillus septicus*, the *Bacillus aerogenes capsulatus* and the *Streptococcus putridus* have been found in cases of puerperal infection. They are the chief agents in the production of the clinical condition formerly known as uterine *sapræmia ;* but it is now known that saprophytic bacteria seldom, if ever, occur alone and unassociated with pyogenic bacteria in uterine infections.

(c) *Specific Bacteria.*—The *gonococcus*, the *pneumococcus*, the *Bacillus diphtheriæ*, the *Bacillus tetani*, and the *Bacillus typhosus* have all been found in cases of puerperal infection. The gonococcus produces, as a rule, only local pelvic inflammation, but occasionally fatal septicæmia may result. The other specific bacteria are rarely found and probably only occur in association with the pyogenic cocci. Infection with the pneumococcus is particularly liable to result in general peritonitis. The diphtheria bacillus produces in the genital tract the same

species of false membrane which characterises throat infection by the same organism. Puerperal tetanus occurs, but is extremely rare.

Mixed Infection.—Puerperal infection is not always due to a single species of organism ; and, further, in a large number of cases it cannot even be said that the organisms concerned belong to a single member of the three great groups just described. Saprophytes may be found in company with pyogenic cocci, and the latter with certain of the specific organisms ; or members of all three groups may be associated in a single case. This fact, as we shall see, exerts an important influence upon the clinical features and treatment of cases of puerperal infection. It is believed that the most virulent cases are those due to mixed infection. Uterine *sapræmia* can only be properly diagnosed after bacteriological examination has excluded the presence of pyogenic organisms.

II. **The Sites of Infection.**—(a) *Wounds.*—After every normal labour the continuity of the surface of the genital tract is broken by separation of the placenta, and by the more or less considerable lacerations and abrasions which occur in the cervix and vagina, vulva or perineum. The placental site is a raw surface or wound particularly liable to infection, because of its great area and many large venous channels, and because drainage from the uterus is often imperfect. Through these wounds, if they become infected, pyogenic bacteria may invade the tissues of the body generally, or toxins may be absorbed into the circulation. From infected wounds of the cervix and vaginal vault bacteria will find, in the lymphatic channels, a ready way of access to the pelvic cellular tissue, and may thus give rise to pelvic cellulitis. It is probable, from what is known of the pathological anatomy of puerperal sepsis, that generalised infection usually occurs by extension from an infected uterus, and seldom by extension from infected wounds of the cervix or vagina. Severe cases of puerperal infection are almost always the result of uterine infection.

(b) *Dead Tissue.*—A certain amount of dead tissue is always present in the puerperal uterus : viz., fibrin, bloodclot, and a thin layer of decidua which undergoes necrosis and is cast off. This may be supplemented by fragments of placental tissue or chorionic membrane which remain attached to the uterine wall. Thus the conditions which favour the growth of bacteria always exist in greater or less degree in the puerperal uterus. In difficult or instrumental labour, areas of sloughing from prolonged or excessive compression may also occur.

III. **The Sources of Infection.**—Puerperal infection is, with very few exceptions, a *conveyed infection*, the bacteria having been conveyed or introduced into the uterus by the hands or instruments of the person who has attended the labour. The

few exceptions comprise cases of *autoinfection*, which, though admittedly rare, do occasionally occur. There are two different sources from which bacteria may be conveyed into the uterus ; they may come (a) from outside sources of infection—*extrinsic* bacteria, or (b) from the " area of operation," which is the skin and mucous membrane of the perineum, vulva and lower part of the vagina—*intrinsic* bacteria. From the preventive point of view it is of great importance that this double source of conveyed infection should be clearly appreciated.

(a) Bacteria from outside sources of infection are introduced into the genital tract by surgically unclean fingers, instruments, swabs or matter applied to or introduced within the vulva. The risks of infection will be greatly increased by the presence of sores upon the hands of the medical attendant or nurse (" septic fingers ") ; or by recent contact with other sources of infection, such as operations on septic cases, dressing septic wounds, the performance of post-mortem examinations ; or by insanitary personal or general surroundings of the patient. But of all modes of infection, the one most to be feared is the carriage of bacteria from a case of puerperal infection to a parturient or recently delivered woman.

(b) Infection with *intrinsic* bacteria is brought about by their transportation, by hands or instruments, from the lower contaminated to the upper sterile part of the genital tract. It has already been pointed out that the vulva, like all other areas of skin, always contains numerous bacteria, and hands or instruments, after being carefully sterilised, may become reinfected in passing through it. The close proximity of the anus to the perineum and vulva renders these parts peculiarly liable to contamination with intestinal bacteria, which are often of high potential virulence. The lower part of the vagina also always contains bacteria ; although these are usually bacteria of a low virulence, such as the *Staphylococcus albus* and *Bacterium coli*, and various saprophytes, streptococci are sometimes present and may be transported into the uterus by the examining finger or instruments. Infections brought about in this manner by *intrinsic* bacteria are truly conveyed infections, and it is quite erroneous to regard them as " autoinfection " merely because the patient's body is the source of the transported bacteria.

Autoinfection.—By autoinfection is meant the spontaneous infection of wounds of the genital tract by organisms resident within it before the onset of labour. We are only justified in ascribing a case of puerperal infection to autoinfection if all sources of conveyed infection can be absolutely excluded. Such cases are extremely rare, but severe infections do occasionally occur after labours during which not a single vaginal examination was made, or in which the whole labour was com-

pleted before the arrival of the doctor or midwife. There are two modes, in theory, in which autoinfection may occur. Pathogenic bacteria resident in the cervix or upper part of the vagina either may directly inoculate wounds of these parts, or may reach the placental site by ascending growth. Bacteriological investigations support the possibilities of autoinfection only up to a point. It is true that many observers have been able to cultivate bacteria from the upper part of the vagina in healthy pregnant women; and it has been shown that the cavity of the normal puerperal uterus does not always remain sterile for more than twenty-four hours after the expulsion of the placenta, but becomes progressively more contaminated as the puerperium advances. But the bacteria found in these situations are of low virulence and are mostly saprophytes; streptococci whose cultural and other reactions denote high potential virulence are rare. Although, therefore, on bacteriological evidence, autoinfection may account for slight infections, it seems probable that severe streptococcal infections should always be regarded as the result of conveyed infection. There can be little doubt that sexual intercourse during the last few weeks of pregnancy is an important source of infection, and patients and their husbands should be warned accordingly.

Although satisfactory evidence of autoinfection by virulent streptococci may be lacking, the same cannot be said for the gonococcus. Puerperal infection may be caused by gonococci which, during pregnancy, have been lurking in some part of the vagina or cervix, or even in the decidua. The possibility of this organism remaining latent for a considerable time, and then assuming well-marked activity on being transferred to a new location is well known, and doubtless accounts for its occasionally causing serious results in lying-in women. In this way acute ascending gonorrhœal inflammation may arise, involving not only the uterine cavity, but also the ovaries, tubes, and peritoneum. Again, when such local conditions are present as carcinoma of the cervix, appendicitis, cystitis, or pelvic abscess, acute infection of the genital tract from these sources may also occur spontaneously. But when puerperal sepsis accompanies acute specific fevers, such as scarlatina, typhoid or diphtheria, it is much more probable that the infection has been carried from without than that it has reached the genital canal through the circulation, although it cannot be denied that this is theoretically possible.

IV. **The Conditions which Predispose to Infection.**—These are mainly two. Firstly, the conditions which are likely to lead to the introduction of bacteria into the genital tract during or shortly after labour; these concern chiefly the character of the labour. Secondly, the conditions which are

likely to allow the bacteria to multiply and infect; these concern chiefly the resistance to infection offered by the tissues of the patient. As regards the character of the labour, the chances of bacteria being introduced will be greatly increased by a prolonged or difficult labour, by premature rupture of the membranes, and by such operations as the induction of labour, forceps, internal version or craniotomy. But the operation most to be feared is manual removal of the placenta. On the other hand, the risk of bacterial introduction is reduced to a minimum in natural labour conducted without any vaginal examinations. The general resistances of the patient will be reduced by anything which exhausts or debilitates her, or which subjects her to collapse and shock, such as previous ill-health, the albuminuria of pregnancy or eclampsia, prolonged or difficult labour, and especially by ante-partum or post-partum hæmorrhage. The local resistance of the tissues of the parturient canal will be lowered by bruising and laceration.

B. **Pathological Anatomy of Puerperal Infection.**—The pathological anatomy of puerperal infection conforms to that of surgical infections in general, and the only special features it possesses are dependent on the anatomical peculiarities of the genital tract and its relations to surrounding structures.

Cases of extreme virulence, which reach a fatal termination in from two to three days, are sometimes met with in which almost no morbid changes can be found in the genital tract. These are called *fulminant* cases, and are usually due to virulent streptococcic infection, the bacteria directly entering the blood and lymph vessels, and producing almost no reaction at the points of entry. Death is due to an overwhelmingly rapid formation of toxins within the circulation. In the majority of cases of puerperal infection, however, well-marked alterations are found in the genital tract and elsewhere, but they differ greatly in their nature and distribution.

The lesions of puerperal infection may be divided into two main groups: the initial lesions at the sites of infection, and the lesions resulting from the spread of the infection. The latter may be again subdivided into the lesions consequent on the spread of the infection to surrounding structures, and those consequent on the generalised and metastatic spread of the infection.

(*A*) *The Lesions at the Site of Infection.*

Infections of the uterus—acute endometritis and metritis.

Infected tears of the perineum, vagina and cervix.

(*B*) *The Lesions resulting from the Spread of the Infection.*

(*a*) Extension to surrounding structures.

To the pelvic cellular tissue—parametritis.

To the peritoneum—pelvic peritonitis, general peritonitis.

To the tubes and ovaries—acute salpingitis, pyosalpinx, ovarian abscess.
To the pelvic veins—thrombophlebitis.

Fig. 301.—Uterus from a Case of Placenta Prævia and Puerperal Septicæmia ; Streptococcic Infection : Death on Fourth Day.
It will be noticed that the thrombosed placental sinuses are in the lower uterine segment.

(*b*) Generalised infection—septicæmia, pyæmia, metastatic abscesses.

(1) *The Uterus.*—The general condition of the wall of the

uterine cavity is variable. In pure streptococcic infection it is usually smooth and uniform, with little evidence of superficial necrosis. Thus in Fig. 301 the greater part of the wall is smooth, but the placental site presents the usual elevated and irregular appearance. In mixed infection, on the other hand, the wall is shaggy and irregular from the presence of necrotic tissue.

The condition of the uterine wall is, in general terms, similar to that of an infected wound in any other part of the body; but the local appearances depend to a great extent upon the type of organisms present. It is generally agreed that two varieties may be distinguished, and they have been named *putrid* and *septic endometritis*.

Putrid Puerperal Endometritis.—In this condition the uterus is large and flabby, and usually contains adherent fragments of membranes, placenta or blood-clot, and usually an offensive odour is noticeable. There may be a thick necrotic layer of decidua, or polypoid masses may be found on the placental site; sometimes bubbles of gas are visible in the decomposing tissues. This form is mainly due to infection by putrefactive bacteria, with which the streptococcus and *Bacillus coli* are usually associated. On microscopic examination of the uterine wall a well-marked zone of leucocytic infiltration is found beneath the necrotic layer; this zone appears to form a barrier to the advance of the infecting organisms, for none are found either in it or in the tissues lying beneath it (Fig. 302). Accordingly, with this variety of puerperal endometritis, symptoms of general infection are absent, for the dissemination of the organisms is prevented.

Septic Puerperal Endometritis.—In this form the uterus is small, the cavity lined with a greyish layer of exudation, there are no retained tissues to be seen, there are no bubbles of gas, and no fœtor. It is caused by the group of pyogenic cocci, of which the streptococcus is the most frequent, being found either alone or in association in 60 to 70 per cent. of cases (Lea). This variety may, however, also be due to the *Bacillus coli* or the gonococcus. On microscopic examination it is found that the zone of leucocytic infiltration, although present, is less extensive than in the first-named variety, and numerous organisms will be found to have invaded it—*i.e.*, the barrier to dissemination of the organisms is feeble. In some cases the leucocytic zone is not continuous, presenting gaps here and there, through which the organisms can be seen to have made their way freely into the lymphatic spaces and blood-vessels of the subjacent muscle. In this way the frequency with which streptococcic uterine infection is accompanied by symptoms of general septicæmia can be anatomically explained. Occasionally, when the leucocytic zone is complete, streptococcic

endometritis may produce only symptoms of localised uterine infection.

In cases of mixed infection by saprophytic and pyogenic organisms, atypical appearances will be presented in the uterus. Adherent fragments of placenta or chorion may be found in either variety of puerperal endometritis.

The *muscular wall* of the uterus also is usually more or less inflamed (*metritis*) in both forms of puerperal endometritis. In rare instances of the septic variety multiple small interstitial

FIG. 302.—Puerperal Endometritis, showing marked Development of the Leucocytic Zone. (Whitridge Williams.)

a. Fibrin layer. *b*. Leucocytic zone. *c*. Muscular wall with vessels.

abscesses may form. In very rare instances sloughing of more or less extensive areas of the muscular wall occurs—the so-called *metritis desiccans*. The venous channels in the general uterine wall are frequently found thrombosed and inflamed (*Thrombophlebitis*), and small collections of pus may sometimes be found in the thrombi and outside the vessel walls in the tissues around them.

The *serous coat* may escape altogether, or in cases of great severity patches, or a complete coating, of lymph may form upon it; in such cases the whole of the pelvic peritoneum, along with the tubes and ovaries, is generally inflamed (*perime-*

tritis, pelvic peritonitis). Infection of the peritoneal coat may be brought about by extension from the infected uterine cavity through the lymphatics, or through the advance of the infection by direct continuity from the uterine cavity to the mucous membrane of the Fallopian tubes, and through the abdominal ostia to the pelvic peritoneum.

(2) *The Cervix, Vagina, and Vulva.*—Lacerations of these parts, when infected, assume the appearance of ulcers with a dirty greyish base, produced by the formation of a false membrane consisting of the superficial necrosed tissues. In cases of severe perineal lacerations which have become infected, superficial sloughing may occur over large areas of the injured tissues. Sometimes areas of sloughing are met with in the anterior vaginal wall. They are produced by prolonged and severe compression of the part between the fœtal head and the pubes, or between the forceps and the pubes ; they are accordingly most often met with after a long and difficult second stage. If the patient survives, such sloughs separate during the first seven to ten days of the puerperium, and usually they produce a vesico-vaginal fistula, since the base of the bladder is necessarily included in the area of compression and sloughing.

(3) *Pelvic Cellular Tissue.*—Large inflammatory effusions (*cellulitis*) may be met with in one or both broad ligaments, or they may be so extensive as to include the whole of the pelvic cellular tissue and spread to that of the iliac fossa and anterior abdominal wall. Such an effusion between the layers of the broad ligament is often called *parametritis*. The inflamed cellular tissue may suppurate, forming a large abscess. The cellular tissue usually becomes infected by lymphatic extension from wounds of the cervix ; cellulitis is probably always accompanied by a certain amount of uterine infection, but clinically the condition of the cellular tissue obscures that of the uterus, and the case is regarded mainly, if not entirely, as one of cellulitis.

(4) *Peritoneum, Fallopian Tubes, and Ovaries.*—Peritonitis of variable extent is usually found in fatal cases of puerperal infection. A certain amount of pelvic peritonitis often accompanies severe cases of uterine infection which recover, and if limited to the pelvic cavity it is not necessarily fatal. Occasionally acute general peritonitis may be set up by an infected uterus. The infection may occur by direct lymphatic spread, but sometimes may arise from lacerations of the uterus or vagina, through which direct infection may occur ; this is often seen in rupture of the uterus, or after perforation of the uterus from induction of abortion by unskilled persons (criminal abortion). The Fallopian tubes usually become infected by direct spread from the uterine cavity, and from them the infection spreads to the ovaries and the pelvic peritoneum.

Pyosalpinx and ovarian abscess sometimes form, either rapidly or after a considerable interval. These, however, occur more frequently with gonorrhœal than with other forms of infection.

(5) *Pelvic Veins.*—The thrombosed vessels beneath the placental site frequently become infected by organisms which penetrate the blood-clot. Thence they spread in the sub-endothelial connective tissue along the walls of the vessels, chiefly the veins, setting up a spreading phlebitis. Phlebitis may spread from the infected uterus into the broad ligaments; thence it may pass upwards through the left ovarian vein to the renal vein, and through the left iliac veins to the inferior vena cava, and the resulting long line of blood-clot may even reach the right ventricle. In other cases it passes downwards into the femoral vein, causing femoral thrombosis—a variety of the condition clinically known as *phlegmasia alba dolens* (see p. 525).

Septic phlebitis is probably to be regarded as a defensive reaction against the spread of the infection; as has been mentioned, the most virulent infections do not show it at all. Following upon the phlebitis, coagulation of blood occurs, and the affected vessel thus becomes partially or wholly blocked (thrombosis). The clot thus formed is infective, and in some cases minute particles become detached as emboli, and being carried to distant parts by the blood stream, the condition known as *pyæmia* results. Such cases, although severe, nearly always run a prolonged clinical course.

(6) *Generalised Infections.*—These may be brought about by the dissemination of streptococci or other pyogenic or specific bacteria throughout the body by the blood stream (*septicæmia*), or by the detachment of septic emboli from infected pelvic veins (*pyæmia*). The lesions are widespread and include septic endocarditis and pericarditis, septic pneumonia, empyema infective arthritis, meningitis, and panophthalmitis. The commonest site of embolic infection is the lung, resulting in septic pneumonia. Metastatic abscess formation is characteristic of pyæmia, and the commonest situations are the joints and the cellular tissues.

Clinical Varieties of Puerperal Infection.

The following clinical varieties must be considered :—

(1) Uterine infection : puerperal *septic endometritis* and *metritis*, in which the infection may either remain limited to the uterus, or may become generalised and give rise to a *secondary septicæmia.*

(2) Primary septicæmia.

(3) General peritonitis.

(4) Local pelvic inflammation : *salpingo-oöphoritis, pelvic cellulitis, pelvic peritonitis.*

(5) Puerperal thrombophlebitis: (*a*) the acute infective form, giving rise to *pyæmia*, and (*b*) *phlegmasia alba dolens*.

(6) Infected tears of the perineum, vulva and vagina.

1. **Uterine Infection.**—This is far the commonest variety and is, besides, nearly always the initial stage of all the other clinical varieties of puerperal infection. From what has been said about the pathological anatomy of puerperal infection it will be evident that cases of uterine infection can be grouped into two main types, which depend upon the nature of the infecting bacteria: (1) mild infections and (2) severe infections.

The *mild infections* are caused by bacteria of low virulence, amongst which those belonging to the saprophytic group often predominate. The bacteria remain limited to the uterine cavity and do not tend to penetrate deeply the uterine wall or to extend beyond it. To designate cases of this type the term *uterine saprœmia* has in the past been used; but we now know from bacteriological observations that infection with saprophytic bacteria only is extremely rare and that pyogenic bacteria, though it may be in small numbers and of low virulence, are nearly always demonstrable in even the mildest cases of uterine infection. It is, therefore, better to discard this term altogether. The *severe infections* are due to virulent streptococci and other pyogenic bacteria which invade deeply the tissues of the uterine wall, giving rise to *parenchymatous metritis* as well as to endometritis, and tend to become widely disseminated through the lymphatic or vascular systems.

The Onset of Uterine Infection.—In the initial stage the differential diagnosis of the two varieties is difficult, and it will be best, in the first place, to consider the general symptoms of the onset of uterine infection without reference to its sub-divisions.

The occurrence of evanescent rises of temperature in the puerperium from trivial causes has been already referred to; it will be remembered that in such cases the pyrexia is moderate, is of brief duration, and yields easily to treatment. The possibility of the occurrence of intercurrent febrile affections, unconnected with the puerperal state, is also to be borne in mind. But the general rule, which must be rigidly applied, is that every case of "fever" arising in the puerperium should be regarded as the result of infection unless some other cause for it can be definitely recognised.

The onset of *uterine infection* almost always occurs in the first puerperal week, and, except in rare instances, during the first four to five days. Cases occurring within the first three days are probably due to infection during labour. In *mild* cases the onset is characterised by rise of temperature, as a rule gradual, to 101° or 102° F., corresponding rapidity of the pulse, frontal headache, and more or less feeling of general illness. In *severe* cases the rise of temperature is usually rapid, and is ushered in

or quickly followed by a rigor ; the frequency of the pulse is exaggerated, and the headache and feeling of illness are more pronounced. Though a mild onset generally indicates a mild infection, this is by no means constant, and a case which begins with slight symptoms may prove to be one of very severe infection.

The condition of the uterus must be carefully observed at the onset of uterine infection. Involution is usually delayed or arrested, except in the severest streptococcal infections, where the bacteria become generalised without producing any inflammatory reaction in the uterus. When the uterine cavity contains infected blood-clot, or pieces of adherent placenta or membrane, the uterus is abnormally large for the puerperal date and is tender to the touch.

The lochia frequently become putrescent (offensive) in uterine infection. This is especially likely to occur if the uterine cavity contains blood-clot, membrane or placenta, and if saprophytic bacteria have obtained access to it. The presence of an offensive discharge is in itself no indication of the mildness or severity of the infection. It merely indicates that saprophytic bacteria are present. It may occur alike in mild or in severe infections ; on the other hand, infections of the greatest severity may occur without any decomposition of the lochia whatever. The presence of an offensive discharge does not necessarily indicate that the decomposition is taking place in the uterus ; the lochia may decompose at the vulva or in the vaginal canal, while the uterus remains unaffected, and no unfavourable symptoms whatever occur.

From what has just been said it will be clear that it is often impracticable at the onset of a case of uterine infection to distinguish between a mild and a severe case and to forecast its course. Time is required in order that the general course of the illness and the effects of local treatment may be observed. But the treatment of uterine infection, to be efficacious, must be applied without delay, and consequently the onset of the disease must often be treated before a differential diagnosis of the two types is practicable. Treatment will be described later on ; in the meantime the general features of a typical case of mild and a typical case of severe infection may be described, it being continually borne in mind that cases of mixed infection which resemble both, and differ from either, are frequently encountered.

(1) *Mild Uterine Infection.*—The three outstanding clinical features of this condition are *pyrexia*, *decomposition of the lochia*, and *arrest of the process of involution* of the uterus.

The time of onset varies with the date of infection. If infection has occurred during labour, the symptoms usually appear on the second or third day ; if infection has occurred subsequent

to delivery, the symptoms will appear later. As a rule, the first symptom to appear is fever, which may be slight (100° to 102° F.), as in Fig. 303, or severe (102° to 104° F.), as in Fig. 304; a slight shivering may accompany the initial rise, but a pronounced rigor is unusual. The pulse-rate rises to an extent proportionate to the temperature. A certain amount of headache and general malaise are present, but the patient does not appear to be seriously ill. On examination of the abdomen the uterus will usually be found to be unduly large for the puerperal date; it is tender to the touch, and softer than normal in consistence. The vulval pads should always be examined, when the fœtor of the lochia, if present, will be perceived, and shreds

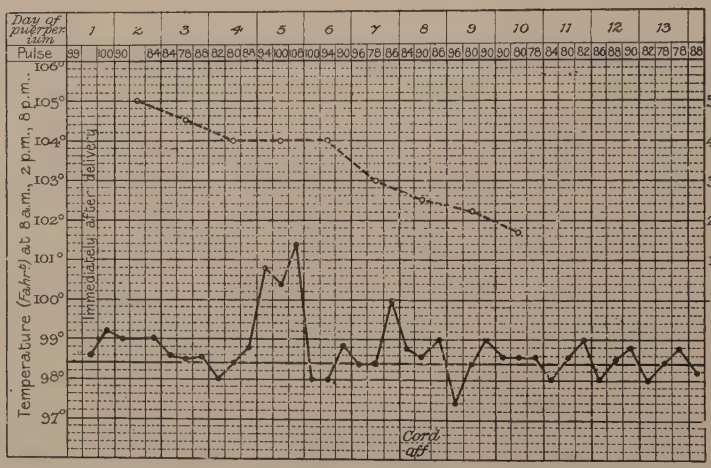


FIG. 303.—Chart of a Slight Case of Uterine Infection, showing the Rise of Temperature and Arrest of Involution on the Fourth, Fifth and Sixth Days.

of tissue may be found upon them. The amount of the lochia is often profuse, and sometimes an admixture of fresh hæmorrhage may be observed. A mild case when suitably treated can usually be cured in two or three days; more severe cases may last for a week or upwards before yielding to treatment (Fig. 304). If untreated, the symptoms may increase in severity, and generalised infection, indicated by rigors and great rapidity of the pulse, or local pelvic lesions, will follow. Very slight cases of infection are often met with in which the only abnormal indications are slight fever (100° to 101° F.) and a little enlargement without tenderness of the uterus. Or a similar degree of fever may be the result of infection of superficial tears of the vulva, perineum, or vaginal walls. The patient may appear to be perfectly well; she complains of no headache, and the lochia

are healthy. It is possible that such cases are sometimes due to imperfect uterine drainage, resulting perhaps from the recumbent position, or from the presence of an uninfected clot in the uterus, preventing the free escape of the lochia.

(2) *Severe Uterine Infection.*—The symptoms bear a broad resemblance to those just described, but they are of much greater severity and are much less amenable to local treatment. The onset is almost always acute and is seldom later than the third day of the puerperium ; it may be said that the earlier the onset the more severe will be the disease. An initial rigor occurs in the majority of cases, and often the patient is quite unconscious of illness until the onset of shivering. The tempera-

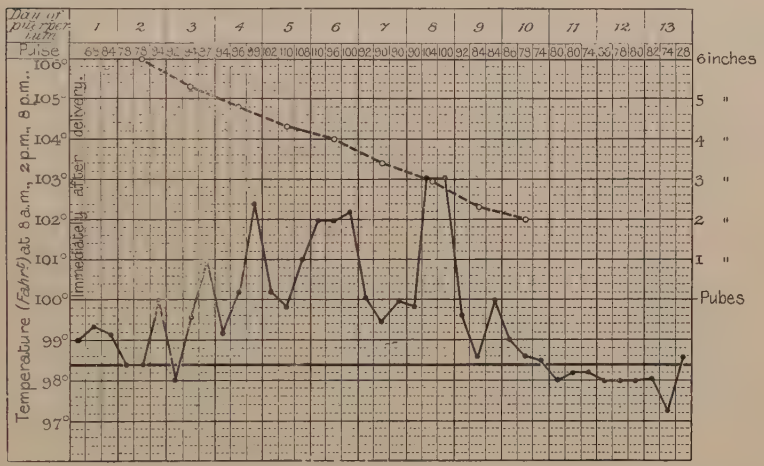


FIG. 304.—Chart of a moderately Severe Case of Uterine Infection which lasted from the Second to the Eighth Day.

ture runs an irregular course ; there is as a rule no apyrexial period, but a remission of two or three degrees occurs at some period of each day. In cases of moderate severity the highest diurnal temperature is about 102° or 103° F., in severe cases it may be 104° or 105° F. The pulse-rate is always rapid, and is to a great extent independent of the temperature. The pulse may be over 120 with only a moderate degree of fever ; in severe cases it may reach 130 or 140. The uterus is seldom unduly enlarged or tender. The lochial discharge is sometimes increased in amount, and is partly bloody and partly purulent ; if saprophytic as well as pyogenic bacteria are present, the lochia will be offensive. In very severe infections the lochia may be very much diminished in amount. On vaginal examination no local signs of pelvic inflammation will be found, but vulval, vaginal or

cervical lacerations may show signs of infection. Pyogenic bacteria will be found in film preparations or grown in cultures taken from the uterine cavity, but blood cultures remain sterile.

The further course of a case of severe uterine infection depends upon whether the infection remains limited to the uterus or extends beyond it. If the infection remains limited, the symptoms gradually decline, and the temperature begins to fall after an illness lasting about a week or ten days.

Extension of the Infection.—If the infection extends, the symptoms and course will depend on the mode and direction of the extension : (1) it may extend locally or by contiguity to the surrounding pelvic structures, giving rise to salpingo-oöphoritis, cellulitis, thrombophlebitis or peritonitis ; (2) it may become generalised, the bacteria gaining access to and multiplying in the blood stream, giving rise to septicæmia. This is a *secondary septicæmia*, and is not to be confounded with a *primary septicæmia* (p. 520) or with *pyæmia* (p. 524).

Secondary Septicæmia.—Septicæmia secondary to uterine infection makes its appearance usually from about the tenth to fourteenth day of the disease, though it is impossible clinically to recognise precisely when the infection becomes generalised. There is a progressive aggravation of all the symptoms at about the period when, under favourable circumstances, one would expect them to decline. The temperature becomes higher, and may reach 104° or 105° F. more than once in the twenty-four hours, and the daily remissions are greater. The pulse is very rapid, and may reach 130 or 140, and is to a great extent independent of the temperature ; this disproportionate rapidity of the pulse is an almost certain indication of septicæmia. A persistent pulse-rate of over 120 is of grave significance. The whole aspect of the patient changes for the worse. The *tongue* becomes dry, and in severe cases brown and cracked. *Vomiting* is of serious import, especially when accompanied by abdominal distension and rigidity. *Diarrhœa* is a not infrequent symptom, and when uncontrollable or involuntary it is of serious omen. *Sleeplessness*, often accompanied by severe headaches, is another unfavourable sign. The *intelligence* is usually unimpaired, even in fatal cases almost up to the moment of death, but delirium, passing into coma, sometimes supervenes as the end approaches. *Pain* is an infrequent symptom of septicæmia ; in the initial stages there may be severe aching pain in the back, limbs, joints, and head, but this does not persist. The *joints* and synovial sheaths sometimes show serous effusions in septicæmia, one after another being implicated, but the effusions are usually reabsorbed without suppuration occurring. *Cutaneous rashes* of erythematous or papular type are not uncommon ; they are usually transient, and may disappear in one part to reappear in another. *Ulcerative endocarditis, pericarditis, pneumonia,*

pleurisy and *empyema* may occur in septicæmia ; they are very grave complications, and usually indicate a fatal termination.

When *blood cultures* are positive they afford a proof of the septicæmic nature of the infection and establish the identity of the bacteria. Detection of bacteria in the blood is not easy, and a single negative result should carry little weight. It is necessary to take a considerable amount of blood (10 c.c.) from a vein and incubate it for seventy-two hours before it can be pronounced sterile ; the most favourable opportunity to take the blood is when the temperature is high, or shortly after a rigor.

Diagnosis.—The only swift and sure method of accurately diagnosing severe uterine infection in its early stage is bacteriological examination of the uterine cavity. This method should be employed without delay when a puerperal patient presents symptoms indicative of a severe pyogenic infection, viz., a rapid rise of temperature to above 101° F., with other suggestive symptoms lasting for more than twenty-four hours. It decides

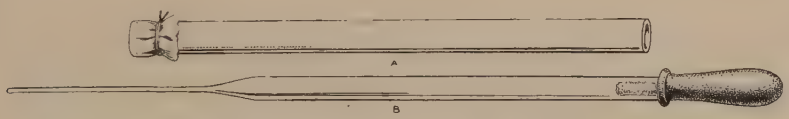


Fig. 305.—Apparatus for obtaining secretion from cavity of puerperal uterus (as used by Dr. G. P. Western, Bacteriological Department, London Hospital). A, outer glass tube (length about 7 inches), covered at end with cap of stretched rubber (end of a finger-stall) ; the tube is boiled before use. B, inner pipette, drawn out fine at one end, with plug of wool and teat at other end ; sterilised in a flame before use.

whether the uterine cavity is infected or sterile, it identifies the infecting bacteria, and it enables an autogenous vaccine to be prepared. At the same time a catheter specimen of urine should be taken for bacteriological examination, for the only other common infection whose symptoms compete with those of severe uterine infection is acute pyelonephritis due to the colon bacillus. Very careful technique is required in obtaining material from the uterine cavity ; there must be the least possible manipulation of the uterus, and every precaution must be taken against the risk of infecting the uterine cavity. With the patient in the left lateral position at the edge of the bed, the vulva is cleansed, and a large Sims' speculum is passed along the posterior vaginal wall short of the cervix. The cervix thus exposed, it may be with the additional aid of retraction of the anterior vaginal wall, is carefully cleansed by swabbing. The outer glass tube (Fig. 305, A)

is then passed directly through the cervix, care being taken to avoid touching the vagina, until it is felt to reach the fundus ; it is then withdrawn for 1 inch, and the pipette (Fig. 305, B) is passed through it, perforating the cap, and secretion is aspirated by the teat. After withdrawal of the tubes the uterus is copiously douched with a gentle stream of weak antiseptic solution. The pipette is sealed in a flame and sent to a bacteriologist. Material thus taken from the uterus may reveal, in films or on culture, pure streptococci or other pyogenic bacteria in pure strain or in combination. In clinically severe cases the streptococcus will be found in roughly three-fourths of the cases. Bacteriological examination of the vaginal secretion is useless for purposes of diagnosis, for it usually contains pathogenic and non-pathogenic bacteria even when the uterus itself is not infected. It must be borne in mind that fever of slight or severe type may be caused by infection of wounds of the lower part of the genital tract—cervix, vagina, vulva and perineum—while the uterus itself remains free from infection. These parts should, accordingly, always be examined and the condition of the wounded surfaces carefully noted.

In cases of difficulty it should be the rule to regard as septic in origin all cases of pyrexia in the puerperium for which some other cause cannot be clearly demonstrated. Such disorders as influenza, scarlet fever, and enteric fever may no doubt attack lying-in women and produce a train of symptoms resembling those of septicæmia ; but they must never be loosely diagnosed, although the temptation to do so may sometimes be difficult to resist.

Prognosis.—At the onset of a case of uterine infection the prognosis must always be guarded. If a pronounced improvement follows the local treatment described later on it shows that the infection has remained limited to the uterus, and the prognosis is good. Yet a case which begins as a mild one may later on develop into one of generalised infection.

The course of septicæmia may be greatly prolonged ; after considerable improvement has occurred serious relapses may supervene, and local infections, such as phlegmasia or salpingitis, may appear. The occurrence of a localised pelvic infection in the course of a case of septicæmia is well known to be a favourable event, for it has the effect of localising or "fixing" the infection. The symptoms of gravest prognostic significance are the following :—

(1) Pulse-rate persistently over 120.
(2) Persistent vomiting and tympanites, with dry brown tongue.
(3) Sleeplessness.
(4) Repeated severe rigors.
(5) Inability to take sufficient nourishment.
(6) Signs of pericarditis, endocarditis or pneumonia.

Estimates by different observers of the rate of mortality of puerperal uterine infections vary greatly; this is not surprising when the varied degrees of severity which may be met with are borne in mind. Lea states the general mortality, including mild cases, to be about 10 per cent., but in severe cases of generalised infection it is probably as high as 60 or 70 per cent. Krönig and Whitridge Williams, on the other hand, have each reported fifty cases of streptococcic infection with a mortality of only 4 per cent.

Treatment.—When once the infection has manifested itself, treatment must be promptly applied, for, like most wound infections, only in its earliest stages can its spread be controlled. We will first consider the principles upon which treatment is based.

Principles of Treatment.—These are the same as those which underlie the treatment of surgical infections in general, viz.: (1) disinfection of the wound; (2) free drainage of the wound; (3) specific treatment by sera and vaccines; (4) the introduction into the general system of chemical substances to destroy the bacteria (chemotherapy); (5) the maintenance of the patient's resistance by general medical and nursing treatment. The first two require special consideration in relation to puerperal uterine infections.

(1) Disinfection of the Uterine Cavity.—It is impossible to disinfect the uterine cavity. Attempts to do so by curetting followed by the intrauterine application of powerful antiseptics such as carbolic acid or tincture of iodine, or by intrauterine douching, are not only useless, but are likely to do more harm than good. Even in the early stage of an infection, when the bacteria have penetrated only the decidua, the curette cannot possibly remove all the infected tissue; when the bacteria have penetrated the muscular wall, the attempt is even more hopeless. The curette, by removing the superficial layers of the soft uterine wall, destroys the protective leucocyte zone and opens up fresh blood and lymph channels through which the infection may spread and become generalised. The use of the curette in puerperal infections cannot, therefore, be too strongly condemned. The application of powerful antiseptics, such as pure carbolic acid, even in the early stages of infection, probably does more harm than good; they do not completely eradicate the bacteria, and their caustic action reduces the vitality of the tissues and diminishes their power of resisting the spread of the infection. Nor can the uterine cavity be disinfected by the routine use of antiseptic intra-uterine douches, for the antiseptic cannot possibly penetrate the uterine wall sufficiently far to kill the bacteria, and can do no more than wash away discharges and loose *débris*.

On the other hand, when the uterine cavity contains decomposing pieces of placenta, membrane or blood-clot, these should be removed; and in cases where the unduly large size of the

uterus and profuse offensive lochia indicate this, the decomposing tissue should be removed by the operation known as "exploration" of the uterus with the finger (p. 517). This is the only circumstance in which the principle of "disinfection of the wound" is applicable in puerperal uterine infections.

(2) Drainage of the Uterine Cavity.—Drainage from the uterus in the early days of the puerperium tends to be imperfect; the loose collapsed walls of the lower uterine segment and cervix become apposed and prevent the free escape of discharges, and the same effect may be produced by pieces of retained membrane or blood-clot. Continuous drainage of the infected uterus by rubber or other drainage tubes is not efficient or safe. Drainage of the uterus is dependent on the active expulsion of discharges by the contractions and maintained retraction of its muscular walls; adequate drainage in uterine infection is, therefore, secured by giving the patient such drugs as ergot, pituitrin or quinine. Posture is also of the utmost importance in securing free drainage. While the patient is lying down in bed a pool of discharge collects in the upper end of the vagina, and drainage from the uterus can only occur by an overflow from this pool; but when the patient is placed in the Fowler position, with the head of the bed raised about 2 feet, the vagina can drain freely. A method of securing intermittent drainage of the uterus has recently been advocated by Hobbs. He introduces a thin rubber catheter into the uterus, and injects through it with a syringe about 10 c.c. of a 5 per cent. solution of tincture of iodine in glycerine; the catheter is left in the uterus for about eight hours. The injections are made daily. Their effect is to stimulate a flow of lymph from the walls of the uterus and to excite contractions, and drainage is assisted by the contractions and by the presence of the catheter. The method has had great success in his hands and is likely to be much used in the future.

Passing now from principles to practice, and bearing in mind that the differentiation between slight and severe cases can seldom be made immediately, the initial treatment must follow the same general principles for all cases, and will depend on the severity of the symptoms rather than the nature of the infection.

Treatment of Slight Cases.—Gradual rise of temperature to 100° or 102° F.: moderate rise of pulse; no shivering or rigor; headache slight; uterus large; lochia often, but not always, offensive. In such cases the infection is probably slight. They can usually be cured by promoting uterine drainage by hot vaginal douching with a mild antiseptic (lysol, a teaspoonful to a pint), ergot in full doses by the mouth, or, better still, by the intramuscular injection of a reliable ergot preparation twice or three times a day, and free purgation with castor oil. The douching and ergot and purgation, by stimulating the uterine

muscle, promote drainage and assist the expulsion of retained dead tissues, if any there be ; drainage is assisted by keeping the patient in Fowler's position. In two or three days the symptoms will probably subside ; if they do not, the case must be treated according to the direction given below for the severe type.

Treatment of Severe Cases.—Temperature 103° F. or higher, with or without a rigor ; pulse 100 to 120 ; headache and general malaise well marked ; lochia may be scanty and inoffensive, or profuse and fœtid. In all such cases a bacteriological investigation of the uterine cavity must be made. In addition, it must be decided without delay whether the uterus is to be "explored" or not. In the absence of clinical indications that the uterus contains decomposing material, this should not be done. But if the presence of decomposing material is indicated by undue size of the uterus and profuse fœtid lochia, it should be removed, so long as the operation is performed during the early days of the infection.

Exploration of the Uterus.—The patient is anæsthetised and placed in the lithotomy position supported by a Clover's crutch. The operator is gowned and gloved, the vulva is shaved and purified, and the vagina is dried and swabbed out with tincture of iodine. Material for bacteriological investigation is now obtained from the uterus in the manner already described. Mechanical dilatation of the cervix is never required during the first week of the puerperium. One hand is placed over the fundus of the uterus to steady it, and one or two fingers of the other hand are introduced through the cervix. The cavity and walls of the uterus are carefully searched for pieces of placenta, membrane or blood-clot. These are removed with the fingers, assisted, if need be, with ovum forceps. Only loose or definitely projecting pieces of material should be removed, and no attempt should be made to scrape clean the rough uterine wall with the finger tips. When the operator has satisfied himself that the uterus is empty, a copious intrauterine douche is given of lysol or tincture of iodine, a teaspoonful to a pint. The intramuscular injection of pituitrin or ergot completes the operation. The removal of adherent placenta may be followed by hæmorrhage, which is soon checked by the hot douche and the intramuscular injection. The patient is afterwards kept in the Fowler position, and drainage is further promoted by regular daily doses or injections of ergot, pituitrin ($\frac{1}{2}$ c.c. three times a day) or quinine sulphate (gr. v. in a cachet six-hourly), and hot vaginal douches twice daily. The effect of removing gross masses of decomposing material from the uterus usually has a most beneficial effect, the temperature and pulse forthwith declining. But occasionally the operation is followed by great exacerbation of the symptoms, the explanation being that laceration of vessels allows the general dissemination of bacteria by the blood

stream, or that septic thrombi are detached from the uterine or pelvic veins. Yet the *early* removal of decomposing tissue from the cavity of an infected uterus must be undertaken, and the earlier it is carried out the less the risk. It is only in the early days of the infection that exploration of the uterus is permissible ; after the uterus has become the seat of parenchymatous metritis, with septic thrombi in the uterine and probably also in the pelvic veins, the risk of disturbing the thrombi and disseminating the infection is great. Further local treatment is not required. The routine use of intrauterine antiseptic douches is of doubtful value, and probably is more harmful than useful. The introduction of the tube disturbs and often hurts the patient ; the douche fluid cannot possibly penetrate far enough into the infected tissues to destroy the bacteria, and the manipulations may help to spread the bacteria and detach septic thrombi. An intrauterine douche can do no more than wash out discharge, and this end can be attained by posture combined with the use of drugs to stimulate uterine activity.

Sera and Vaccines.—Before sera and vaccines can be scientifically administered the nature of the infection must have been discovered ; the importance of a bacteriological examination of the uterine cavity in the early stages of all clinically severe infections has already been emphasised. But it is reasonable and proper to use anti-streptococcic serum, even when a bacteriological diagnosis has not been made, because the chances are so greatly in favour of the infection being a streptococcal one. Owing to the fact that there are many varieties of streptococci, each requiring its own antitoxin, the best serum is the *polyvalent* one, prepared by using the various species. The doses must be large, and the earlier in the course of the disease the serum is given the more efficacious is it likely to be. An initial subcutaneous dose of 50 c.c. is recommended, followed the next day by 30 c.c. and the next by 20 c.c. The strictest aseptic precautions must be taken in the preparation of the skin and the syringe. Improvement is indicated by a fall of temperature and pulse.

Vaccine treatment is not so simple. Stock vaccines are not suitable. The services of a bacteriologist are required for the preparation of an *autogenous vaccine*, and it is advisable that he should supervise the dosage. The initial dose, as a rule, should be a small one in a case of puerperal infection, *e.g.*, 5,000,000 ; this dose may be repeated at intervals of three or four days, and gradually increased up to 30,000,000 or 40,000,000 if improvement follows and the reaction is not too marked. As the avoidance of delay is so important, the serum should be given at once, in streptococcal infections, while the vaccine is being prepared.

It must be admitted that the results of treatment by sera and

vaccines are in many cases disappointing. Although no harm follows their use, it cannot be said that they have been shown always to exert a decided influence in diminishing either the length or the severity of the infection. Very favourable results have, however, been reported by treatment with an autogenous vaccine obtained from intrauterine cultures in a series of ninety-six cases by Western. It is desirable always to make use of both vaccines and sera when possible in all severe cases, exact bacteriological diagnosis of the nature of the infection having first been made.

Chemotherapy.—The intramuscular or intravenous injection of certain chemical compounds has been most successful in the treatment of some specific infections (for example, salvarsan in syphilis, and quinine in malaria), and from time to time various chemical substances are reported on favourably for the destruction of pyogenic bacteria in local or generalised infections. But the prestige of nearly all has been short-lived, and their extended trial has given disappointing results in puerperal infections. Amongst these substances may be mentioned mercurochrome and other mercury salts, colloidal silver, cerium and eusol. Luker has recently reported favourable results from the daily intramuscular or intravenous injection of quinine bihydrochloride gr. v., combined with serum treatment.

General Treatment.—This includes all measures to maintain the strength of the patient and increase her resistance to the infection. *Food* should be mostly fluid, and milk naturally forms the most important item. Meat extracts, soups and jellies may be added. Alcohol is not required in mild cases, but in severe cases is most valuable, and severely infected patients are able to tolerate larger quantities than those in health. If the bowels are constipated a mild aperient should be given every other night ; moderate diarrhœa may be allowed to continue unchecked ; severe diarrhœa may be controlled by administering starch and opium enemata. *Pyrexia* should not be directly treated unless the temperature rises over 104° F. Antipyretics should not be given, but the use of the wet pack or tepid sponging may be relied upon when necessary. *Sleeplessness* should be controlled by hypnotics. *Subcutaneous saline infusion* stimulates leucocytosis and phagocytosis, and promotes elimination by the skin and kidneys. It may therefore be employed with advantage in the acute stages, a pint of fluid being introduced twice a day for several days ; or a graduated continuous rectal injection may be used for several hours a day. During the course of the illness a careful physical examination of the patient must be made at intervals in order that cardiac, pulmonary and other complications (*e.g.* empyema, pneumonia, abscesses), and collections of pus in the pelvis may be promptly detected.

Hysterectomy.—The removal of the infected uterus has been advocated. It is certainly a logical contention that, as the uterus is the focus of infection, its removal will arrest the continuous passage into the circulation of fresh bacteria produced by the active bacterial development within it. If the proper cases could be unerringly selected there is no doubt this operation would have an important place in the treatment of severe uterine infections. If hysterectomy were done as a routine treatment for all early (*i.e.* localised) cases of streptococcal infection there is no doubt that many women would be saved who would otherwise have died from septicæmia ; but very many women would be operated on who would have recovered under conservative treatment. On the other hand, if the operation is postponed until the case has proclaimed itself as a probably fatal one, the infection will have passed the limits of the uterus and have become generalised ; hysterectomy will then be useless, because its one object has been defeated by the spread of the infection.

Because the proper selection of early cases is such a hopeless problem, hysterectomy has a very limited place in the treatment of puerperal infection. But when an infected fibroid tumour is present, or where there is evidence of abscess formation in the uterine wall, the removal of the uterus may be necessary.

2. **Primary Septicæmia.**—There are "fulminant" cases in which the bacteria, usually streptococci, pass rapidly through the uterine wall and multiply in the blood-stream, so that the infection is a generalised one from the very first. Though the uterus is the site of inoculation, it shows no inflammatory reaction, and the case is not therefore, strictly speaking, one of uterine infection. Blood cultures are positive from the onset of the illness. These cases, rare nowadays, are often fatal in a few days ; they are usually the result of direct inoculation, by hands or instruments, from other sources of virulent infection, such as cases of cellulitis or puerperal infection. On the first or second day after labour, or even before labour is over, there is a severe rigor and a rise of temperature to 104° F. or more, with an exaggerated rapidity of the pulse. The aspect and general condition of the patient become very grave. Death usually occurs in two or three days, though the patient may live for a week or ten days, and very rarely she may even overcome the infection and recover. There is little time or opportunity for treatment. Large doses of antistreptococcal serum should be given intravenously ; sometimes direct blood transfusion, especially in anæmic patients, has been beneficial ; heart stimulants, warmth and saline infusions are indicated.

3. **General Puerperal Peritonitis.** — The results of post-mortem examinations show that this condition is infrequent. Some of the symptoms of general peritonitis—*e.g.* continuous

vomiting, meteorism, irregular pyrexia, and a rapid small pulse —are met with in septicæmia. The clinical diagnosis of general peritonitis may accordingly present unusual difficulties in cases of puerperal infection. A systematic description of the clinical features of this affection is unnecessary in a text-book of midwifery, for it differs little from general peritonitis due to surgical causes, the distinctive symptoms being abdominal pain and rapidly increasing distension accompanied by nausea and vomiting, the latter sometimes persistent. The prognosis is very serious, but free drainage, suprapubic, vaginal, and lumbar, should be established as soon as the diagnosis is made, and the same general and specific treatment applied as in cases of septicæmia.

4. **Local Pelvic Inflammation.**—A well-defined group of cases of puerperal infection may be recognised, of which the main feature is the presence of pelvic inflammatory lesions—*i.e.*, of course, lesions outside the uterus. In such cases the inflammatory process is seldom limited to a single tissue or a single organ, yet it ordinarily manifests itself chiefly in either the *pelvic peritoneum*, the *pelvic cellular tissue*, or the *uterine appendages*. Thus, with pelvic cellulitis more or less peritonitis is usually found as an accompaniment, while with pelvic peritonitis the Fallopian tubes and ovaries are necessarily implicated to a greater or less extent. The relative frequency of occurrence of this group of local puerperal infections is probably not more than 1 in 10 of all cases. The original focus of infection is, in almost all cases, the uterus ; thence the process spreads by direct continuity through the Fallopian tubes to the pelvic peritoneum, or through a cervical tear to the cellular tissue ; or it may spread through the lymphatics of the uninjured cervix to the cellular tissue, or through the lymphatics of the uterine wall to the peritoneum. Occasionally the veins appear to be the chief channels of infection, and a spreading phlebitis occurs which may pass downwards to the femoral vein, or upwards to the inferior vena cava. The comparative rarity with which localised pelvic inflammation follows uterine infection is probably due, in some way, to the protection afforded by the zone of leucocytic activity in the affected uterine wall (see p. 504).

Common Features.—Cases of puerperal pelvic inflammation are probably due to pyogenic organisms of somewhat attenuated virulence, or to auto-infection by the *diplococcus gonorrhœæ*, sometimes also to bowel infection by the *bacillus coli communis*. It is usually stated that they are characterised by a late onset, but this is not strictly accurate. Severe sypmtoms do not as a rule appear earlier than the latter half of the first week—*i.e.* about the fifth or sixth day—but slight symptoms of uterine infection, often overlooked, are almost always present earlier

than this. When such symptoms as moderate elevation of temperature and decomposition of the lochia are disregarded, the real onset of the disease is naturally misunderstood. It is quite possible that if due heed were paid to the significance of these symptoms in such cases, the appearance of the local inflammation might be altogether prevented by early and appropriate treatment. A rigor often occurs, and pelvic pain is a prominent symptom of the onset of some of these affections. Their general course is prolonged, localised suppuration is not uncommon, but a fatal termination is rare. Mild cases, not marked by an acute onset, are probably of frequent occurrence, and, being overlooked or inadequately treated, pass into the phase of *chronic pelvic inflammation* so often met with in parous women of all classes of life.

Pelvic Cellulitis (synonyms : Parametritis, Broad-ligament Phlegmon).—Systematic descriptions of this affection are usually given in text-books of gynæcology ; a few points only require notice here.

An extensive cellulitic effusion forms a hard, immovable, non-tender swelling which may fill the entire pelvis and surround the uterus, or may be limited to, or chiefly apparent in, one or other broad ligament. In the former case the position of the uterus is unaltered ; in the latter the uterus is displaced to the unaffected side. In the early stages when the amount of effusion is small, the swelling, being lateral in position and not immovable, is difficult to distinguish from an inflamed tube and ovary. After a few days the characteristic spread of a cellulitic effusion clears up the diagnosis. Spreading along the cellular tissue planes, the effusion may pass upwards to the iliac fossa and the abdominal wall, forming a swelling palpable by abdominal examination above the inner half of Poupart's ligament, or may track upwards along the ilio-psoas muscle to the region of the kidney.

In some cases a small effusion only is formed, which occurs clinically as an ill-defined, firm swelling, placed laterally to the uterus, and showing a limited amount of mobility ; this usually subsides in from one to two weeks ; a more extensive swelling usually persists for several weeks, but even those of large size as a rule ultimately become absorbed. Sometimes suppuration occurs, indicated by sharp irregular rises of temperature, rigors, exacerbation of pain, and marked increase in the degree of leucocytosis—always present in pelvic inflammation. Cellulitic abscesses usually point either above Poupart's ligament, or in one or other lateral vaginal fornix ; more rarely they rupture into the rectum or bladder. Occasionally they pass out of the pelvic cavity through the sciatic or obturator foramen, to appear on the buttock or the anterior aspect of the thigh. In rare cases of extensive effusion absorption takes

place around the uterus, leaving the pelvis practically free, while outlying parts of the effusion persist and ultimately suppurate, forming abscesses in such situations as the iliac fossa or near the kidney. This condition has been named *remote parametritis.*

Pelvic Peritonitis (*Perimetritis*) *and Salpingo-oöphoritis.*—A *peritonitic* pelvic effusion usually occupies the pouch of Douglas ; it therefore forms a swelling behind the uterus, and when of large size it displaces this organ forwards. It is of softer consistence than a cellulitic effusion, and much more tender to touch. A roof of matter tissues, comprising omentum and large or small bowel, is formed above it ; this roof may be recognisable as an abdominal swelling occupying the hypogastrium, tender to touch, ill-defined in outline, and sub-resonant on percussion. These effusions rarely suppurate ; when suppuration does occur the resulting abscess may be spontaneously evacuated either into the vagina, the rectum, or some other part of the bowel. Spontaneous absorption without formation of pus occurs in the majority of cases, and is usually more rapid than in the case of cellulitis.

Acute tubal or *ovarian inflammation*, leading to the rapid formation of a pyosalpinx or an ovarian abscess, is rarely met with in the puerperium. Chronic inflammatory affections of these organs, insidious in onset, and not leading immediately to acute symptoms, are, however, not uncommon sequels of puerperal infection ; they are usually overlooked until the appearance of some complication, or the chronic ill-health of the patient, leads her to seek advice.

Cystitis may occur in the puerperium from use of the catheter, or more rarely from spontaneous ascending infection *per urethram*, but it does not differ from the same condition as met with under other circumstances.

Treatment of Local Pelvic Inflammations.—The general and specific treatment of uterine infections already described is applicable to these cases also. Treatment should be prompt upon the appearance of acute local symptoms, and before the pelvic inflammatory effusions have had time to become extensive. Prolonged confinement to bed, with careful feeding and nursing, and attention to the daily evacuation of the bowels, will in most cases lead to the absorption of the effusion. Collections of pus should be evacuated without delay, the incision being made in the position indicated by softening ; but the diagnosis of suppuration is sometimes difficult, for the abscess may form in a position inaccessible to clinical examination. Incisions into cellulitic areas should not be made until the local signs of suppuration appear. Careful and repeated estimation of the number of leucocytes in the blood may be of great assistance in diagnosis ; when the number present suddenly rises to 25,000

per cubic millimetre or over, with a high percentage of eosinophile cells, the presence of pus is highly probable.

5. **Puerperal Thrombo-phlebitis.** (*a*) *Acute Infective Thrombophlebitis of the Utero-pelvic Veins : Pyæmia.*—The occurrence of septic phlebitis accompanied by thrombosis in the veins of the uterus has already been mentioned. The infection of the veins is always secondary to uterine infection, and the bacteria concerned are the same. The early symptoms are therefore those of uterine infection.

Pyæmia is a form of infection characterised by extensive thrombo-phlebitis in the pelvic veins, leading to the formation of multiple infective emboli, from which secondary infective foci may be carried to the heart, the lungs, the abdominal viscera, the joints, the synovial membranes, etc. The emboli may consist of minute portions of infected clot which have become detached, or of aggregations of bacteria. Pyæmia is somewhat later in its appearance, and also runs a more protracted course, than septicæmia.

The thrombo-phlebitic changes begin in the uterine or ovarian veins, whence they spread to the external and internal iliac veins, and ultimately to the inferior vena cava ; in the case of the ovarian veins the infection spreads directly to the renal vein on the left, the inferior vena cava on the right. The uterine and iliac veins are found affected at autopsies much more frequently than the ovarian veins.

The embolic complications which may occur in the course of pyæmia lead to such varied conditions as ulcerative endocarditis, multiple pulmonary abscesses, hepatic and splenic abscesses, pyelitis, and joint effusions, either serous or suppurative.

The records of autopsies on women who have died from puerperal septic diseases appear to show that this form of sepsis is frequent, for thrombo-phlebitic changes are evident in from 30 to 50 per cent. of such cases (Lea).

Treatment.—The specific and general methods of treatment already described for cases of septicæmia are to be made use of in pyæmia also. Attempts have been made to limit the spread of venous infection by surgical means.

Ligature or Excision of Pelvic Veins.—During recent years a certain number of cases of pyæmia associated with pelvic thrombo-phlebitis have been treated by this procedure, which is based upon the operation of excision of the external jugular vein in aural pyæmia. The operation is naturally severe, and cannot be undertaken with any hope of success except in the early stages, while the general condition of the patient is good and there are no signs of the formation of embolic metastases. If there is marked œdema of the lower extremity, the thrombosis is probably too extensive to be controlled by these opera-

tions. The vessels may be exposed either by an extra-peritoneal or an intra-peritoneal incision, the latter being preferred, as the affected vessels cannot be sufficiently exposed by the former. Further, thrombotic changes may be found in the vessels of both sides, and free access to the whole of the pelvis is then required.

A practical difficulty in the application of this operation is the problem of diagnosis. Recognition of thrombo-phlebitic changes in the pelvis by vaginal examination is by no means certain, and these changes are not invariably found in cases which are clinically pyæmic. And further, it is not practicable in all cases to tie off or remove the affected veins owing to the extent of vessel involved; yet the extent of the lesion cannot be gauged without exposing the veins affected.

It is impossible in the meantime to estimate the value of this operation; of some fifty to sixty recorded cases the mortality has been 40 per cent. (Lea), but it must be assumed that many of these were acute cases in which recovery was hardly to be expected. Further experience is necessary before it can be decided whether or not this operation will prove to be of real value.

(*b*) *Phlegmasia alba dolens* (*White Leg*).—This condition is a less acute form of thrombo-phlebitis in which the venous infection extends locally to the main venous trunks of the thigh. The developed condition is characterised by a general swelling of the affected limb from the foot to the groin, its onset being attended by severe pain, pyrexia, and general malaise. Although in the great majority of cases it affects the lower limbs only, in a few rare cases an upper limb has been simultaneously or subsequently attacked. Two varieties, the *thrombotic* and *lymphatic*, may be distinguished.

Thrombotic Form.—In this, the most frequent form, the immediate cause of the swelling is phlebitis of the external iliac or femoral vein, leading to thrombosis, and obstruction to the venous return from the limb. In the upper part of Scarpa's triangle the thrombosed vein can be readily felt as a firm, tender, thick cord. In thin subjects definite swelling just below Poupart's ligament may be visible. The swelling of the limb is due to rapidly developing œdema, which appears first in the foot and quickly extends to the thigh; the swollen parts are soft, and pit on pressure, and are at first of a dusky blue rather than a white colour. Usually the femoral vein is involved by continuous spread from similarly affected uterine or pelvic veins; sometimes, however, no evidence of pelvic phlebitis can be obtained clinically. But the condition is almost certainly septic in all cases, and streptococci have been found in the femoral clot. Probably these organisms, circulating in the blood stream, may set up phlebitis in a remote part by attacking the

endothelium of the vein-wall. Slight cases of this variety, in which only the foot and leg are affected, are not uncommon.

Lymphatic Form.—In some cases no signs of femoral thrombosis can be found; the swollen limb has a tense, white, glistening appearance, and does not pit on pressure; there may be enlarged and tender lymphatic glands felt in the groin. In the early stages the skin shows a slight flush, and later on small areas of dermatitis or superficial gangrene may appear. It is stated that in such cases the effused fluid in the limb is not serum (as in œdema), but coagulable lymph. It is much rarer than the thrombotic form, and is probably due to lymphatic infection setting up a deep cellulitis in the affected limb. It is, of course, septic in nature.

It is not at all infrequent for cases to be met with in which both factors, venous and lymphatic infection, occur, giving rise to swelling of atypical characters.

Clinical Features.—A more or less acute onset is characteristic of this affection. It occurs in the great majority of cases in the latter half of the second week of the puerperium (tenth to fourteenth day), although it may appear as early as the sixth or as late as the thirtieth day. Acute pain is felt in the affected limb, and the temperature may rise rapidly to 102° or 104° F.; slight shivering or sometimes a well-marked rigor may accompany these symptoms. There has often been a certain amount of pyrexia during the first puerperal week, as is the case with the local pelvic inflammations—*i.e.* asepsis has not been successfully maintained (Fig. 306). The acute pain and the fever last from three or four days in a mild case to ten or twelve days in a severe one; then both subside concurrently. In the thrombotic form, tenderness and induration will be found along the line of the femoral vein. The affected limb is immobile as if from paralysis, and frequently the presence of fluid can be detected in the knee-joint. The left leg is much more commonly affected than the right; this is no doubt due to the preponderating frequency of the first position of the vertex, which makes cervical laceration much more common on the left than on the right side, and predisposes to infection of the left broad ligament, its vessels and lymphatics. Both limbs are affected in about one-third of the cases, but almost always consecutively after an interval of one or two weeks, a simultaneous onset of the disease in both limbs being extremely rare. Lying-in-hospital statistics show that phlegmasia occurs about once in four hundred cases of labour.

Treatment.—Treatment should be chiefly directed to the immobilisation of the affected limb, and the relief of the local pain. Almost the only risk attending the disease is pulmonary embolism from detachment of a portion of blood-clot from the thrombosed vein. To prevent the occurrence of this accident

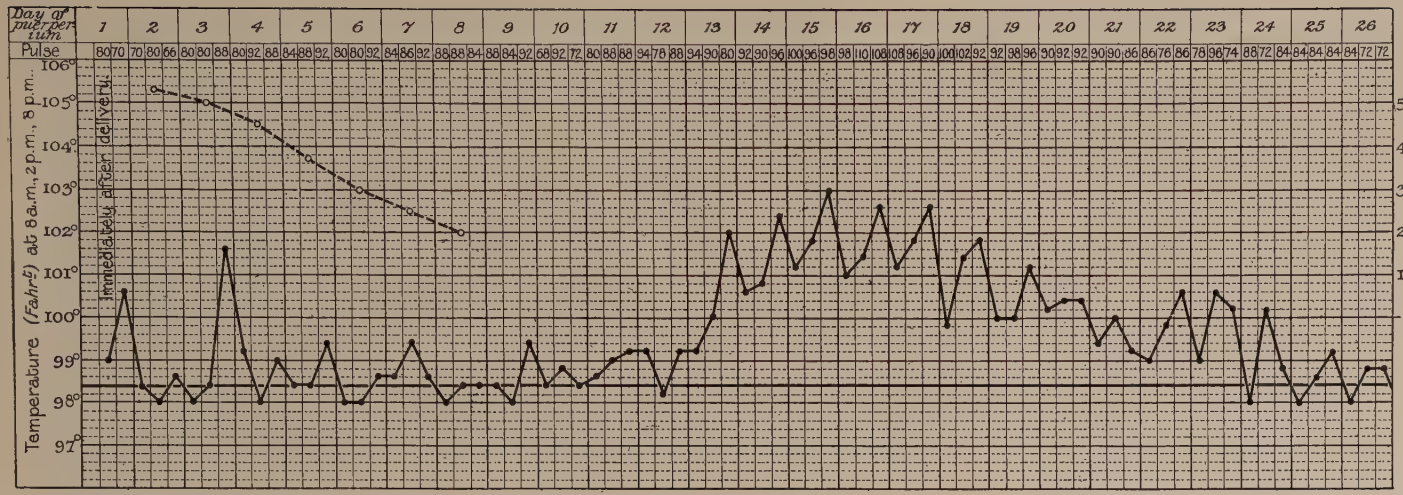


FIG. 306.—Chart of a Case of Phlegmasia Dolens, showing the Onset and the Period of Pyrexia.

the limb should be laid upon pillows and immobilised by placing heavy sandbags in contact with it on both sides, from the hip down to the foot. Voluntary movement must not be allowed for fourteen days after the cessation of pain and all febrile symptoms. Many weeks or even months may elapse before all the swelling has disappeared from the limb, and a certain amount of pain and stiffness on movement may persist for even longer periods. In the early stages pain is best relieved by the application of hot fomentations. After the pain has disappeared the limb must be kept carefully wrapped up in cotton wool, and shielded from pressure with a 'cage.' In cases of unusually acute onset attended with a rigor, antistreptococcic serum may be employed. The administration of citric acid in ten-grain doses three times daily is believed to retard the spread of the clot by diminishing the coagulability of the blood. Massage is useful in the later stages when pain and swelling persist.

Inflammation of the Mammary Glands (Mastitis, Mammary Abscess)

Unless proper precautions are observed during the process of suckling, the mammæ may become infected by various pathogenic and pyogenic organisms which gain access to it usually through superficial skin-cracks, or sometimes, possibly, through the ducts which open upon the nipple. Bacteriological observations show that bacteria are present in human milk in a very high percentage of lying-in women, under apparently healthy conditions of the breasts and nipples. The *staphylococcus aureus* is the organism most commonly present, and with it may be associated the *staphylococcus albus*, the *B. coli* and streptococci. Streptococci were isolated by Dudgeon and Jewesbury from 49 per cent. of samples of human milk taken in the early days of the puerperium, but only 2 per cent. of the streptococci were hæmolytic. It seems probable, therefore, that the importance assigned by clinical observations to nipple-cracks in the production of mastitis has not been over-estimated; for if these organisms may occur in the milk-ducts without causing inflammation, it must be their entrance into the lymphatics through a wound of the surface which sets up the process. The physiological engorgement of the breast at the beginning of lactation, which reaches its height on the fourth day, does not lead to mastitis unless infection also occurs through one of the channels just indicated. The inflammation may occur (1) in the subcutaneous cellular tissue—usually under or near the areola (*pre-mammary abscess*); (2) in the substance of the gland (*intra-mammary abscess*); (3) in the sub-glandular connective tissue (*retro-mammary abscess*); the last-named variety seldom follows infection through the nipple, but usually results from

empyæma, or disease of the ribs. The foci of infection are often multiple; suppuration frequently but not invariably takes place, and abscesses sometimes form in more than one, or even in all three, of the localities just indicated. Mastitis may occur during pregnancy, but this is rare; in the puerperium it is most commonly found during the first two or three weeks, but may be met with much later than this. The infecting organism is usually the *staphylococcus aureus*.

The onset of mastitis is attended with diffused redness and severe pain in the affected gland. Not infrequently a wedge-shaped area of skin-flushing is formed, the apex being towards the nipple, and probably represents the area of a milk-duct with its tributaries. A rapid rise of temperature, headache, and other signs of general malaise occur, and then a firm and very tender swelling appears at some part of the gland. Suppuration may be attended by rigors, and the usual local signs—softening of the inflamed area, with œdema of the skin, or redness and tension if the abscess is superficial. A *pre-mammary* abscess sometimes opens spontaneously upon the surface or into a large milk-duct, leading to the discharge of pus through the nipple. Sometimes both glands are affected, but seldom simultaneously, the second probably becoming directly infected from the first through suckling or through lack of surgical cleanliness.

Treatment.—The *prophylaxis* of mammary inflammation consists in the proper management of the breasts during pregnancy and suckling, which has been already described. When nipple-cracks are promptly and thoroughly treated, mastitis very seldom ensues. If, owing to the death of the child or for any other reason, the mother does not suckle, the nipples should be carefully cleansed with an antiseptic solution, and the breasts protected by cotton-wool and tightly bandaged. If they become very painful, the bandage may be removed and an evaporating lotion (*e.g.* eau de Cologne and water) employed for a few hours, and the bandage then reapplied. A saline or other aperient should be given daily for the first two or three days. Continuous pressure with the aid of free purgation will, as a rule, quickly arrest the activity of the glands.

The first signs of inflammation in the breasts should at once be met by the following measures: (1) cessation of suckling from the affected gland, the secretion being drawn off as required with a breast-pump; (2) the local application of moist heat by fomentations or poultices; (3) purgation. If the breast is extensively affected, or if signs of suppuration occur, suckling must be entirely suspended, and the unaffected gland tightly bandaged over cotton-wool to secure even pressure. Suckling from a suppurating breast must be strictly forbidden, for the milk is probably always infected. Suppurating areas must be promptly laid open when recognised. The incisions

should, as far as possible, be made parallel to the course of the large milk-ducts which converge upon the nipple. The abscess cavity is frequently multilocular and of irregular shape ; septa must be broken down with the finger to ensure efficient drainage of all parts of the cavity, and a counter-opening at some dependent part may be required. Rapid healing usually follows the evacuation of the pus. Tonics such as iron and quinine are always indicated during convalescence, which may be prolonged when the general health is unsatisfactory. The functional adequacy of the gland in a subsequent pregnancy as a rule is not affected, for the amount of gland tissue destroyed by suppuration is usually small. Sometimes, however, the gland is so disorganised by multiple foci of suppuration that its removal becomes necessary.

Puerperal Hæmorrhage : Secondary Post-partum Hæmorrhage

Hæmorrhage may occur at almost any period of the puerperium, and may be due to a variety of different conditions. In *slight cases* it takes the form of an undue amount of bleeding during the first three days, undue prolongation of the hæmorrhagic stage of the lochia, or recurrence of bleeding after the lochia have become serous. Such cases may be due (*a*) to retention in the uterus of a small portion of placenta or chorion, or blood-clot, which may or may not become infected ; (*b*) to delayed involution caused by not suckling, or by general ill-health ; (*c*) to uterine congestion caused by backward displacement of the uterus.

In *severe cases* a sudden severe hæmorrhage may occur, or there may be continuous bleeding of moderate but not alarming extent, or irregular profuse losses of blood. Such cases are due (*a*) to the *separation* of retained pieces of placenta of considerable size, especially if they become infected ; (*b*) to the formation of a placental polypus ; (*c*) to puerperal inversion of the uterus ; (*d*) to the presence of new growths in the uterus—*e.g.* a fibroid which has become infected, or is being extruded into the uterine cavity, carcinoma of the cervix, or lastly chorionepithelioma (chorionic cancer).

Severe bleeding may occur in the second or third weeks of the puerperium from the separation of a piece of placental tissue. Occasionally cases, almost equally severe, occur in which there is no evidence of placental retention, and in which no other local cause for the hæmorrhage can be found. In these cases there is probably a deficiency both of thrombotic closure of the utero-placental vessels and of retraction of the uterine muscle. Cases due to either of the two first mentioned causes are to be treated in the same manner as cases of primary post-partum hæmorrhage

The clinical association of chorionic cancer with the puerperium is of considerable importance, and a short description of this disease is accordingly necessary.

Chorionic Cancer

This growth, which has been known first as Deciduoma malignum and then as Chorionepithelioma, is more correctly called Chorionic Cancer. It is a malignant tumour arising either in immediate, or more or less remote, connection with pregnancy, and situated most commonly, but not invariably, in the uterus ; in this organ it forms a soft hæmorrhagic growth occupying the usual site of the placenta—*i.e.* the fundus and adjacent portions of the anterior and posterior uterine walls (Fig. 307). The primary growth may, however, be situated in the vaginal walls, the labium majus, the Fallopian tube, or the ovary. The disease is characterised clinically by the occurrence of irregularly recurrent and often violent hæmorrhages in the puerperium, following an abortion usually of a hydatidiform mole or, more rarely, a full-time labour ; the interval between the end of pregnancy and the onset of these symptoms is, however, very variable. Other symptoms quickly appear—viz. a foul discharge, progressive anæmia, cachexia, fever, and sometimes rigors. Metastatic growths are quickly formed, and in many cases this tumour destroys life with almost unexampled rapidity. After much discussion and many contradictory observations, it has now been definitely proved that it arises from the chorionic epithelium, both layers of which are represented in the specific cellular elements of the tumour. It therefore is clearly of embryonic, not maternal, origin.

Microscopical Characters.—The cell elements which are typical of this tumour are the following (Fig. 309) : (1) large irregular multinucleated masses of protoplasm in which cell boundaries cannot be recognised ; these are derived from the syncytium ; (2) small polyhedral cells with large nuclei lying in closely packed masses ; these are derived from Langhans' layer ; (3) large mononucleated cells, and multinucleated giant cells, collected in masses, or invading the stroma of the uterine tissues ; these are probably derived from both (1) and (2). In addition to these elements, definitely recognisable chorionic villi are sometimes present, either of normal appearance or in a condition of hydatidiform degeneration ; from these villi the origin of the three varieties of cells just described has been traced by a number of different observers (Fig. 308). The tumour elements show remarkable powers of invasion ; they attack the uterine tissues, and perforate the walls of the blood-vessels (usually veins), and thus become disseminated by the blood-stream. This accounts for the unusually rapid formation

of metastases. The tumour tissues themselves contain much effused blood and tend to undergo rapid necrosis ; the greater part of the growth is usually found to consist of *débris* of broken-

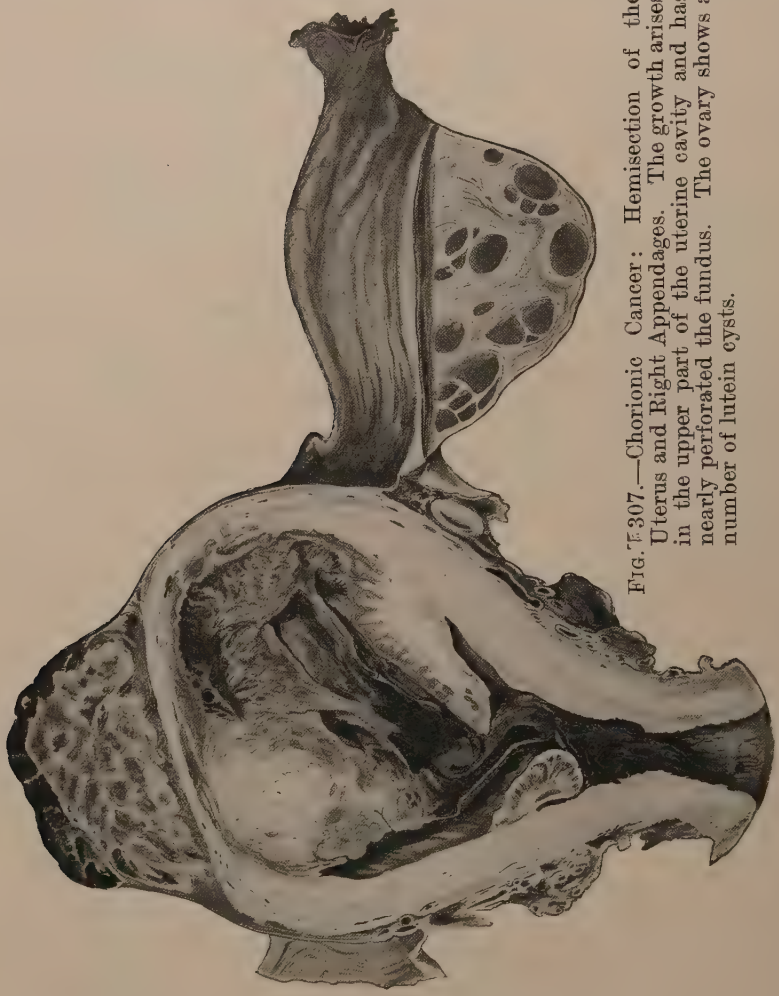


FIG. 307.—Chorionic Cancer: Hemisection of the Uterus and Right Appendages. The growth arises in the upper part of the uterine cavity and has nearly perforated the fundus. The ovary shows a number of lutein cysts.

down tissue and clot ; only at the growing edge can the characteristic elements be found.

The striking resemblance of the cell elements of this tumour to the malignant or perforating variety of hydatidiform mole has been referred to on a previous page ; this constitutes one of the chief difficulties in the microscopic diagnosis of chorionic cancer.

Clinical Diagnosis.—Cases of chorionic cancer following quickly upon an abortion have been frequently mistaken for uterine infection associated with decomposition of retained placental tissue ("sapræmia"), and treated as such. Both conditions are attended with hæmorrhage, a foul uterine discharge, fever, enlargement of the uterus, and the presence within it of decomposing *débris* of tissue or blood-clot. Clearing out the uterus

FIG. 308.—Chorionic Cancer, Low Power, showing the Origin of the Syncytium and Cellular Elements from a Villus. (Teacher.)

brings a temporary improvement in cases of chorionic cancer, but sooner or later the symptoms all recur with severity, and the uterus is again found to contain considerable masses of *débris*, although completely evacuated at the first operation. The rapid reproduction of decomposing tissue in the uterus under such circumstances is strongly suggestive of chorionic cancer. The ultimate diagnosis can only be made by a skilled microscopist, and in cases of doubt the whole of the tissue removed from the

FIG. 309.—Chorionic Cancer, showing the Character of the Syncytium and Cellular Elements. A portion of Fig. 308 more highly magnified. (Teacher.)

uterus should immediately be placed in normal saline solution and sent to the pathologist with as little delay as possible.

Treatment.—Hysterectomy is the only treatment which offers any chance of success. Cases have been recorded in which this operation has been successful even after the formation of definite metastases in distant parts. It should, therefore, be advised in all cases, however advanced, if there is a reasonable chance of the patient surviving the operative procedure.

Reproductive Insanity

Insanity may occur in association with all stages of the reproductive process; it is usual to describe as separate conditions the insanity of *pregnancy*, the insanity of the *puerperium*, and the insanity of *lactation*. Cases occurring within six weeks of labour are classed as *puerperal*, those occurring later as cases of insanity of *lactation*; this distinction is artificial, for puerperal involution is not completed at the sixth week, and lactation commences on the third day. The term 'reproductive insanity' may conveniently be used to include all three of these varieties.

From the statistics of the Lunacy Commissioners it appears that, among female patients in England, cases of reproductive insanity form about 7 to 8 per cent. of the whole, the incidence being rather greater in public than in private institutions. From the records of 258 cases of reproductive insanity from the Claybury Asylum recorded by Jones, it appears that 21·6 per cent. occurred during pregnancy, 40·6 per cent. during the early puerperium, and 32·4 per cent. later than the sixth puerperal week. With regard to the causes of reproductive insanity, four points of special interest may be noted: (1) about 25 per cent. of all cases are said to occur in single women, and in cases of insanity during pregnancy this preponderance is even greater; (2) in a considerable proportion of cases occurring during the puerperium signs of septic infection are present, and it is possible that the toxic condition of the blood thus induced may determine the outbreak in patients subject to hereditary or other predispositions to mental instability; (3) after septic infection the next most important predisposing disease is eclampsia; (4) the subjects of insanity occurring in connection with lactation are usually debilitated in health by previous child-bearing or by general causes. To these causes must be added in all cases the general personal and hereditary conditions which favour the occurrence of insanity. According to Clouston, the frequency of puerperal and lactational insanity is about 1 to every 400 confinements.

Two prominent types of the insanity of reproduction are now recognised: the acute sub-maniacal type, sometimes going on

to acute mania, and the melancholic type. There is also a type in which hallucinations are prominent. In nearly all cases there are strong tendencies to suicide or infanticide. In pregnancy, 80 per cent. of the cases occur after the fifth month; in the puerperium, according to Rigden, over 90 per cent. occur during the first fourteen days; in lactation, cases occur with almost equal frequency from the second month to the end of the second year. In puerperal cases the most important premonitory symptom is sleeplessness, which is almost invariably met with; when associated with headache and slight fever it is of still greater significance. The onset of the disease is often an acute outbreak of mania, associated with great violence and restlessness. Depressed types of insanity, however, may also occur in the puerperium.

The prognosis of reproductive insanity is better than that of any other variety of insanity; from 70 to 80 per cent. of all cases are said to recover. The premonitory sleeplessness and headache are best treated by large doses of hypnotic drugs, of which paraldehyde is the best. When the disease fully manifests itself, the patient should be immediately removed to an institution for treatment.

Pressure Neuritis in the Puerperium

Occasionally certain individual nerve trunks may become injured by pressure exerted during the second stage of labour. Pain in the leg is then experienced during labour, and this is followed by persistent spasmodic pain along the distribution of certain definite nerve trunks. After some days signs of sensory and motor paralysis appear, such as loss of cutaneous sensation, loss of motor power, and, later, muscular wasting. The commonest nerves to suffer thus from pressure are the 4th and 5th sacral nerves, and foot-drop is then a well-marked symptom. Recovery is slow but almost invariably complete.

Sudden Death in the Puerperium

Cases of sudden death in the puerperium may be due to *syncope*, *coma*, or *pulmonary embolism*.

Syncope is, of course, most likely to occur in subjects of chronic cardiac disease (either valvular or myocardial), in cases of profound chronic anæmia, and in cases where profuse hæmorrhage has accompanied labour or followed delivery. It is well recognised that in cases of mitral stenosis or incompetence the danger is by no means over when the child is born; in a considerable proportion of cases which terminate fatally, cardiac failure occurs in the first week of the puerperium. In some rare instances shock appears to be the cause of the syncope, and sudden death has been known to follow rapid emptying of

the uterus, as in precipitate labour, in apparently healthy persons.

Syncope from cardiac disease can only be treated by cardiac stimulation and the administration of oxygen. When following profuse hæmorrhage or such grave accidents as rupture of the uterus, intravenous saline transfusion or blood transfusion should be performed.

Pulmonary embolism may occur during pregnancy, labour, or the puerperium. It may be caused by detachment of a portion of clot from a healthy thrombosed uterine sinus by violent coughing, by muscular exertion, or during a convulsion ; sometimes it appears to be spontaneous. Pulmonary emboli of this kind may contain a portion of a chorionic villus which has entered a uterine sinus and been carried thence to the lungs. Occasionally air embolism is caused by the injection of air into the uterus ; this has followed puerperal intra-uterine douching, and intra-uterine injections of glycerine for induction of premature labour, when these procedures have been clumsily carried out and air pumped into the uterus. Lastly, pulmonary embolism may occur in cases of phlegmasia dolens by detachment of a portion of the femoral thrombus.

Pulmonary embolism may cause instant death, but this is rare. Usually some hours elapse, during which certain symptoms develop which vary according to the size of the obstructed vessel. If this is large, extreme air-hunger (dyspnœa), with cyanosis, and a rapid feeble pulse are the chief symptoms ; if the vessel is small, the symptoms resemble those of shock—pallor, cold surface, and small feeble pulse. Recovery is not impossible in the latter case, although naturally the prognosis is very grave.

The only treatment possible is cardiac stimulation and administration of oxygen.

Coma may occur in the puerperium in the subjects of diabetes, in connection with eclampsia, or from cerebral hæmorrhage.

Part VI

THE NEW-BORN CHILD

During the first twenty-four hours the child sleeps almost continuously, and should be allowed to lie quietly in its cot. It may be put to the breast every six hours on the first day, and every four hours on the second ; a little secretion is in this way obtained. During the first two days the child should not be allowed to remain at the breast for more than ten minutes, as the amount of secretion is slight and prolonged suction may damage the nipples. If the child is to be nursed, no other food need be given besides what is obtained from the breasts except in the case of premature infants (see p. 553). Meconium is usually passed freely during the first two days ; this consists of a viscid, dark greenish-black odourless material. The amount voided is considerable, and for the first two days the stools consist of meconium alone. It is composed largely of bile salts and pigments, and its evacuation should never be accelerated by giving purgatives. The urine passed during the first few days is usually scanty, distinctly yellowish in colour, and not infrequently it leaves a deposit of pink urates on the diaper. It nearly always contains a trace of albumen.

Breast-feeding

The proper food for the new-born child is its mother's milk ; unless definite and valid reasons exist for feeding it in some other manner, every child should be suckled by its mother for the first six to nine months of its life. This is best for the infant because it is receiving a natural food suited to its special requirements, and best for the mother because a period of mammary activity is a valuable aid to the processes of involution in the genital tract. It is therefore the duty of doctors and nurses to use all their influence with their patients to persuade them always to nurse their babies, unless some adequate reason for not doing so exists. There is no true substitute for breast-milk, and although lusty infants usually thrive on properly regulated artificial food, delicate infants perish in large numbers annually, or grow up into delicate children, for want of breast-feeding. There are many different points to be considered in connection with breast-feeding.

The Process of Lactation.—By lactation is meant the estab-

lishment and maintenance of functional activity in the mammary glands. Certain signs of activity, which have been already described, are present in the breasts during the greater part of pregnancy. For forty-eight hours after delivery no further change takes place ; during the third day the breasts undergo rapid enlargement, becoming tense, nodular, and often very tender to the touch, the skin being tense and glistening. On the fourth day the condition of distension reaches its height and is more severe in a primipara than a multipara. The breasts are then full of thick yellow secretion which can be readily expressed, or may escape spontaneously from the nipple. During the first few days the secretion is known as *colostrum*.

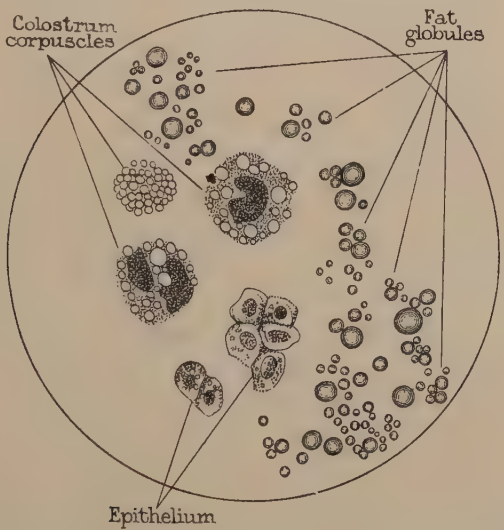


Fig. 310.—The Elements of Human Milk (Colostrum). (Bumm.)

Considerable local pain and general discomfort usually attend this stage, when the milk is said to " come in," and a rise of one or two degrees of temperature may occur for a few hours. Suckling and spontaneous overflow speedily relieve the over-distension of the glands, and in one or two days all symptoms of discomfort disappear, although active secretion will continue for many months. After suckling for two or three days the secretion becomes thinner and less yellow. The mammary secretion is established somewhat sooner in a multipara than in a primipara, and the initial distension is less severe.

Colostrum possesses certain special features which are sometimes of forensic importance as evidence of recent delivery. Its naked-eye appearances have been indicated ; under the

microscope it is seen to contain, besides the polymorphous fat-globules characteristic of milk, certain special elements which have been named *colostrum corpuscles.* These are leucocytes containing large droplets of fat. Epithelial cells in a more or less advanced state of fatty degeneration, which have been detached from the walls of the glandular acini, are also seen (Fig. 310). They disappear after the first few days of suckling. The function of lactation is fully described in text-books of physiology, and need not be referred to here.

Although the breasts contain very little fluid during the first two days, it is most important that the infant should be put to the breast at regular intervals. A little food is in this way obtained, but what is of much more importance is that suckling exerts a reflex stimulation upon the secretory activity of the breasts which is the main factor later on in the maintenance of the full activity of the gland. Glandular activity in all parts of the body is under the influence of a reflex nerve mechanism, the stimulus required being in each case specific. The specific stimulus for the breast is applied through the cutaneous nerves of the nipple by the act of suckling. The child should therefore go to the breast every six hours on the first day, and every three or four hours subsequently. Supplementary feeding is not often necessary during this period. It is advisable to prepare the nipples carefully for the process of suckling during the last few weeks of pregnancy, especially in a primigravida. The skin of the nipples and areolæ should be cleansed once or twice daily, and a mild antiseptic ointment, such as boric acid and white vaseline (1—40), gently rubbed into it. During the later weeks of pregnancy the ducts of the nipple tend to become blocked with dried secretion, and it is important that they should be carefully cleared ; this is a valuable prophylaxis against sore nipples (see p. 542). If the nipples are depressed a breast-pump may be used to draw them out, and with the additional help of frequent gentle manipulation, exciting the reflex erection of the nipple by its muscles, the depression can usually be overcome.

If on the third or fourth day the breasts should become painful from over-distension and the temperature raised, hot fomentations should be applied, and the breasts gently massaged, rubbing towards the nipple. At this stage the ducts sometimes become partly blocked from engorgement, impeding the escape of the secretion, and on the removal of the obstruction the pain and distension disappear.

The Management of Breast-feeding.—Although breast milk is the natural food of infants, and is exactly adapted to their requirements, careless management may lead to unfavourable results.

In the first place, it is important that regularity should be

observed in the hours of feeding ; this is of importance mainly from the point of view of the infant's digestive activity. The intervals between feeds should be sufficient to allow the digestion of the previous meal to be completed. Four-hourly intervals should therefore be the rule during the day-time, and a healthy infant can usually be taught to sleep for six hours or more at night, so that not more than five to six feeds *per diem* are required and the mother gains the advantage of undisturbed nights. No hard and fast rules should, however, be laid down for the optimum frequency of feeding infants. The progress of the child must be closely watched, and it will be found that four-hourly rather than shorter intervals will meet the requirements of the majority of healthy infants.

The amount which is taken from the breast at each feed and the total taken in twenty-four hours are variable. Experience with the 'test-feed' has given surprising and instructive results. The test-feed consists in carefully weighing the infant immediately before and after it has been to the breast ; the increment represents the amount of breast milk which has been taken. This method has placed in our hands a very valuable and practical method of ascertaining whether the amount of milk is sufficient for the needs of the infant. During the first three days the amount required is naturally very small ; but as the flow becomes established the amount progressively increases. Thus for the first twenty-four hours the average quantity is only about half-an-ounce ; by the third day this usually rises to about six ounces ; by the seventh day to twelve ounces, and to nearly double this amount in the fourteenth, averaging between three and four ounces per feed. The size of individual feeds on the same day varies. These figures were obtained over a series of observations in which both breasts were used at each feed, a plan which has much to recommend it, because both breasts are stimulated at each feed and the quantity taken will be increased. In making the test-feed observations an accurate weighing-machine, of the beam-balance type and sensitive to one drachm, should be employed ; the ordinary spring-balance machine is useless for the purpose. Whenever an infant does not appear to be thriving upon the breast the daily test-feed observations should be repeated for several days in succession, so that an average may be struck.

In giving the breast, great care should be taken to adjust the mother's position so that the child can reach the nipple comfortably without having to turn or stretch its neck in the attempt. Difficulty in getting the child to take the breast is often due to neglect of this simple precaution. In ten to fifteen minutes enough will usually have been obtained to satisfy the child, and it will then fall asleep or cease to suck.

It is important that the breast should be emptied by the infant at each feed, for the last of the milk has been found to contain the highest proportion of fat. If the secretion is abundant the child will draw all it wants from one side, and the breasts may be used alternately. If the amount is scanty both breasts should be used each time in order that sufficient may be obtained and also to ensure the advantage to its fullest extent of the physiological stimulus of suckling.

The custom of cleansing the baby's mouth at the end of a feed is unnecessary, for the breast milk which remains in the mouth does not, as is commonly supposed, give rise to thrush. The nipples must be cleansed with boric acid lotion every time the child has been fed, and a piece of clean lint, or preferably a small pad of sterilised cotton, should be kept applied to the nipple, and the breasts lightly supported by a binder. In this way the nipples can be protected from infection, and the occurrence of mastitis prevented.

Difficulties in Breast-feeding.—In rare instances the infant may be too feeble to get the milk, as in cases of prematurity, or, owing to cleft palate, it may be unable to exert proper suction. After difficult labour, in which there has been much compression and moulding of the head, the muscular mechanism of sucking may remain feeble for a few days. In cases of intracranial injury and cerebral hæmorrhage, a striking feature in the infant is the complete absence of the sucking reflex. In other cases the nipple may be retracted or imperfectly formed so that it cannot be properly grasped in the mouth. After several unsuccessful attempts the infant may refuse the breast altogether, especially if it has been fed intermediately from the bottle. In such conditions great care should be taken to draw out the nipple before putting the child to the breast, and if it cannot be made reasonably prominent, the use of a glass or rubber nipple shield will often prove of assistance.

When the nipples are at fault, or when the secretion is scanty, the infant bites and worries the nipple in its efforts to get the milk and there is great risk of the nipples becoming sore. Failure to prepare them, especially in primiparæ, in the manner already described, may also lead to the same difficulty.

Cracked or Sore Nipples.—Primiparæ frequently suffer from the formation of fissures of the nipple at the beginning of the process of suckling. They may occur either at the apex or the base, and in the latter position are sometimes overlooked. They begin as slight abrasions caused by the gums of the child, or by the vigorous use of its buccinator muscles. If the secretion is scanty or if the milk ducts are blocked, unusually vigorous suction will be made, and abrasions may thus be formed upon the nipple. Such abrasions are often seen, but as a rule they give rise to little pain and heal spontaneously in

twenty-four to forty-eight hours. They may, however, become infected, giving rise to fissures. These render the process of suckling extremely painful, and may lead, if neglected, to the formation of a mammary abscess. If at all deep they bleed during suckling, and the blood, being swallowed along with the milk, may later on be rejected so as to create the impression that the child is suffering from hæmatemesis.

Cracked Nipples.—As a useful prophylactic measure against the formation of cracks, the nipple may be inuncted with yellow oxide of mercury (B.P., 2 per cent.) after each feed. Should, despite this, the nipple become damaged, it is best to stop suckling from the affected breast forthwith until the crack has healed. The management from this point needs special care. The infant has to obtain the greater part of its food from the other breast, which will respond to the demand for an increased supply. The milk from the damaged breast must be squeezed off by hand at the regular feed-times and given to the child with a spoon. By this means the activity of the affected breast will be maintained, and the nipple will heal because it is rested. All the treatment the cracked nipple requires is absolute cleanliness and the continuous application of this ointment. In severe cases where the cracks become infected, a more potent disinfection is required; fomentation will be useful, Friar's balsam is a valuable dressing, and when both breasts are damaged, suckling may have to remain in abeyance for several days. The preservation of lactation will now depend on the skill and thoroughness with which the expression of the milk by hand is carried out. Supplementary feeding with a suitable cow's milk mixture is usually necessary until suckling is again possible; it should be given by a spoon, lest a lazy preference for the bottle be established.

It must again be pointed out that severe fissures requiring such treatment should be avoided by proper preparation and management of the breasts.

Contra-indications to Breast-feeding.—It is only in very exceptional circumstances that a doctor should advise a mother not to nurse her child. She may, however, suffer from certain morbid conditions which unfit her for nursing; for example, active pulmonary tuberculosis, decompensated heart disease, acute illnesses such as pneumonia and severe influenza, chronic renal disease. Much more rarely there are certain infantile conditions which greatly interfere with breast-feeding, such as cleft palate, hare-lip, or great feebleness, as from prematurity. We have already seen that severe fissures of both nipples usually necessitate a temporary suspension of breast-feeding; incurable retraction of the nipples will prevent it altogether, and in acute mastitis the affected breast must be rested until the infection is cured.

It should be noted with regard to the infantile conditions that the breast milk may be drawn off and given by a spoon as long as it lasts, but in the absence of the normal stimulus of sucking this will not be for many days. In the case of premature babies it is of great importance to give them breast milk in this way if it can be obtained.

Growth and Progress of the Child.—The only true test of successful feeding is the condition of the child. During the first three days it loses weight owing to the evacuation of the meconium and to loss of fluid through the kidneys, the skin and the lungs ; this loss often amounts to 8 or 10 ounces, and the larger the infant the greater is the loss of weight which occurs. As a rule the infant begins to regain weight at the end of five or six days, but this may be delayed if the establishment of full mammary activity and satisfactory suckling is tardy. The birth-weight is usually regained at the end of ten days. During the remainder of the first month a gain of 4 to 7 ounces a week is satisfactory.

About the third or fourth day the character of the infant's motions begins to alter ; the meconium disappears, and fæcal matter, yellow in colour, alkaline in reaction, and of a semi-liquid consistence, takes its place. Three or four motions are usually passed daily. Urine is passed freely and in considerable amount, so that the diapers are frequently wetted. The umbilical cord should undergo dry aseptic necrosis ; a line of demarcation forms at its junction with the abdominal wall, and about the fifth or sixth day, under normal conditions, it separates spontaneously, leaving a small clean ulcer, which cicatrices rapidly. It is, however, not very uncommon for the root of the cord to undergo a moist form of necrosis without offensive odour, and in these circumstances separation may be delayed until the second or even the third week. A cord in this condition must be treated with the most scrupulous care, and kept covered with boric acid or some other non-irritating antiseptic such as the boric acid, zinc and starch powder (boric acid, oxide of zinc, and starch, equal parts). The skin of a healthy infant often desquamates during the first week. Towards the third or fourth day it becomes of a yellowish tinge, and in some cases the conjunctiva becomes similarly coloured. This is the result of a physiological process of hæmolysis occurring in the liver, and is not a true jaundice, the pigment being derived from the blood, not from the biliary secretion. It passes off in a few days, and is not associated with any unfavourable symptoms.

A weight-chart should be kept, which will greatly assist in forming a general view as to the infant's progress. A steady rather than a rapid gain of weight is desired ; yet every infant may occasionally remain stationary in weight for a day or two,

and too much importance should not be attached to a temporary check.

An important criterion of progress is the behaviour of the infant. Screaming, restlessness and failure to sleep for the greater part of the day and night indicate that the child's comfort has not been achieved. It will often be found that such a child is being overfed, either by being put to the breast too frequently, or by being allowed to take too much milk at a feed. Other signs of overfeeding are flatulence and vomiting after meals, polyuria and frequent stools, which are loose and tend to be green; the buttocks may become reddened and excoriated. The child's weight is increasing. The remedy is to lengthen the interval between feeds and curtail the time spent at each. Test weighings will show whether both or only one breast can be allowed at each feed. The underfed infant remains stationary in weight or loses ground. It is lethargic, sleeps for long stretches, and is soon fatigued by sucking. The stools are small, scanty and infrequent. The temperature is subnormal. Test weighings show that the amount taken at each feed is small and the total daily supply insufficient. The urine is scanty, and pink urates may be deposited on the napkin. In such a case there are certain means at our disposal to augment the supply of milk. If extra breast milk can be obtained from a healthy foster-mother it will, by satisfying the baby's needs, increase its energy and thus promote more powerful suction. This, in time, leads to a better yield from the mother. The latter can be aided also by sponging the breasts with hot and cold water alternately two or three times a day. After suckling, massage of the glands will ensure that they are completely emptied, and milk thus expressed should be fed to the baby. These measures should be continued with perseverance even though no benefit be registered for several days. If no foster-mother is available the shortage of milk must be made up at each feed with a suitable mixture of cow's milk and water, the weighing machine deciding how much is necessary. The daily number of feeds must be kept up, or even increased, to provide the stimulation necessary for secretion.

Composition and Characters of Human Milk.—The reaction of human milk is alkaline, but on exposure to the air it rapidly changes by lactic-acid fermentation, becoming first neutral and finally acid. Its specific gravity varies between 1030 and 1034, and it contains about 88 per cent. of water. In suspension fat is found. In solution are found sugar (lactose), certain nitrogenous substances (caseinogen and a small proportion of lact-albumen, or whey proteid), inorganic salts (chloride of sodium, phosphates of lime, sodium, potassium, and magnesium), and traces of free gases (carbonic acid, oxygen, nitrogen). These various constituents are constantly present, but their propor-

tions vary at different periods of lactation. The following table has been compiled by Cameron and Söldner, and their results have been generally confirmed by others :

Period.	Proteids.	Fat.	Sugar.	Mineral Salts.
1st week. .	2·0%	2·8%	5·4%	0·34%
2nd ,, . .	1·6%	3·1%	6·2%	0·27%
4th ,, . .	1·1%	3·8%	6·4%	0·22%
3rd month .	1·0%	2·9%	6·7%	0·20%

An analysis of 94 samples of human milk by Carter and Richmond, taken at varying periods of the first month of the puerperium, gives the following arithmetical mean :

Specific gravity	1030 to 1031
Water	88·04
Proteid	1·97
Fat	3·07
Sugar	6·59
Ash (salts)	0·26

It will thus be seen that the secretion of the first week contains the largest proportion of proteids and salts ; after this period the proportions of these constituents steadily diminish. Fat is found to increase up to the end of the first month, and then to fall considerably ; sugar steadily increases in proportion up to the end of the third month.

The average percentages of the three chief ingredients during the first months are—proteid $1\frac{1}{2}$, fat 3, sugar $6\frac{1}{2}$.

Human milk is to be regarded as a food of somewhat variable composition, and it is probable that a corresponding variation exists in the nutritional requirements or the digestive capacities of infants. The mammary secretion of a multipara is believed to be less variable in amount and constitution than that of a primipara. Slight variation in the proportion of proteid, fat, and sugar in human milk appears to exert little influence upon the progress of the child.

Diet is an important factor in maintaining the process of lactation ; food rich in proteids and carbohydrates, but simple in form, and accompanied by a liberal allowance of fluid, is best for a nursing woman. In such a diet milk will obviously form an important item. Alcohol is not necessary. The popular notion that fruit and green vegetables cause digestive disturbances in the child is erroneous. The quality of the lacteal secretion may be injuriously affected by nervous shock, emotion, fits of anger, hysteria, and other nervous disturbances, but we have no precise knowledge of the nature of the changes which occur in it from these causes. From this it follows that

women of a pronounced emotional temperament do not make the best nurses, and psychical disturbances may appreciably diminish the amount of milk secreted, as is shown by the increased secretion which follows their removal. When menstruation occurs in nursing women, a temporary disturbance in the baby may occur, but it is of slight significance, and breast-feeding should not be stopped in consequence. The effect of pregnancy is detrimental to the process of lactation.

Wet-nursing.—When for any reason a child cannot be fed by its mother, undoubtedly the best substitute is the breast milk of another woman. In hospitals infants may be fed for several weeks on milk drawn with a breast-pump from other women who have more than their babies need. Occasionally a woman may be able to nurse her own and another baby. In private work a ' wet-nurse ' is the only way in which an infant can be suckled apart from its mother.

The selection of a wet-nurse throws a serious responsibility upon the medical man. He must be satisfied that the breasts are secreting freely, the nipples healthy and well formed, and the genital organs healthy. The nurse and her own baby must both be free from any taint of constitutional disease, such as syphilis or tubercle. In addition she should be of good physique, with sound teeth, cleanly in habits and of good moral character. It is therefore necessary for the medical man to make a complete physical examination of the mother and her child before selecting a wet-nurse. It is difficult to obtain the services of women of respectable character as wet-nurses, and in any case the greatest care is required to ensure against frauds which a candidate may easily practise, as, for instance, the substitution of another child for her own. A syphilitic infant must not be brought up by a wet-nurse. A prospective wet-nurse whose antecedents are not thoroughly known to the doctor should be submitted to the Wassermann test in all cases, as well as her infant.

Artificial Feeding

The only practical substitute for human milk that we can employ is cow's milk ; the comparative composition of these two is shown in the following table (Rotch) :

—	Human Milk.	Cow's Milk.
Sp. G.	1028 to 34	1032
Proteid	1 to 2 %	3·5%
Fat	3 ,, 4 %	4·0%
Sugar	6 ,, 7 %	4·5%
Salts	0·1 ,, 0·2 %	0·7%

It has been found that, although the average composition is as stated in the table, wide variations occur in the milk of different kinds of cows, and also in the milk of any single animal from day to day. By using the mixed milk of a herd greater uniformity of composition can be obtained than with the milk of a single animal. This is directly the contrary of what was formerly believed to be the case. We have seen that human milk is also subject to considerable variations in composition ; according to Rotch, this is especially the case with the proteids, which may vary from 1·08 per cent. to 4·14 per cent. without producing any ill effect upon the child. It will accordingly be understood that the above table sets forth the average proportions only.

It may be said generally that cow's milk differs from human milk in being acid in reaction, in containing considerably less sugar and considerably more proteid, while the percentage of fat is about the same ; further, the proteids of cow's milk differ in being less easily digestible than those of human milk. Milk proteids are of two kinds : *caseinogen* or coagulable proteid—*i.e.*, coagulable by the enzyme of rennet—and *whey proteids* or non-coagulable proteids—*i.e.*, those which remain in solution after treatment with rennet. The percentage amounts are approximately as follows : in human milk, caseinogen 0·5 per cent., whey proteids 1·0 per cent. ; in cow's milk, caseinogen 3·0 per cent., whey proteids 1·0 per cent.

Roughly speaking, it may be said that in human milk the proportion of whey proteid to coagulable proteid is six times higher than in cow's milk. The practical result of this difference is that the curd of cow's milk is more bulky and much more difficult to digest than that of human milk.

It must also be borne in mind that cow's milk is liable to contamination with pathogenic organisms, and certain epidemic diseases, such as scarlet fever and diphtheria, may be propagated by it. From the use of such preservatives as boric acid, which are often added to milk in hot weather, in order to prevent the occurrence of fermentation, acute gastro-intestinal irritation may be set up. And, further, tuberculous disease is not uncommon in cows, sometimes affecting the udders, but more often the respiratory system. The milk of animals thus affected contains active tubercle bacilli, by which the disease may be set up in the infants to whom it is given. Fermentation may occur in cow's milk, rendering it extremely irritating to the gastro-intestinal mucous membranes.

Ass's milk more closely resembles human milk in composition, not only as regards the proportions of its elements, but also, it is believed, in the digestibility of its proteids. The amount of fat is, however, much less than in human milk. The remarks made as to the contamination of cow's milk apply

equally to ass's milk. The practical objection to the use of ass's milk is that it cannot be obtained except in large towns, and its cost is prohibitive to all but the rich.

The preparation of cow's milk for infant feeding is a matter of the highest practical importance ; the two important steps are sterilisation, and modification in composition.

Sterilisation.—The simplest way to sterilise milk is to boil it for ten minutes ; the boiling-point of milk is 220° F. This destroys all bacteria, including their spores. The objection to boiling is that it destroys the antiscorbutic vitamins, and it requires to be replaced by orange or grape juice. The second method is to place the milk to be sterilised in a water-bath, raise the water to the boiling-point, maintain it at this temperature for twenty minutes, and then remove the vessel containing the milk and allow it to cool. If the milk-containing vessel is only three-fourths immersed in the boiling water the temperature of the milk does not rise much above 180° F. This method is often spoken of as ' sterilisation.' A third method is to employ a water-bath in the same manner, but to keep the temperature of the water at only 170° to 175° F. for thirty to forty minutes. The temperature of the milk will be about 160° F. This is often called ' Pasteurisation.' ' Sterilisation,' so called, destroys practically all germs except the anthrax bacillus, but does not destroy their spores. ' Pasteurisation ' produces much the same result, and if repeated two or three times, milk may be rendered absolutely sterile in this manner. It is desirable to employ the method in which the temperature used is the lowest.

If a fresh and uncontaminated supply of milk can be obtained, this is preferable to any method of sterilisation, but it is agreed that the ordinary milk supplied by dairies absolutely requires to be sterilised.

Modification.—The composition of cow's milk can be approximated to that of human milk in respect of the proportions of the principal ingredients. First the milk is diluted to reduce the percentage of proteids to about one-third ; this will be done by adding two parts of diluent to one of milk. But this procedure will reduce the proportions of fat and sugar to a point much below their level in human milk ; therefore fat in the form of cream, and sugar in the form of lactose are added to the diluted milk in order to bring up their proportions to the proper level. Thus, if one part of milk is diluted with two parts of water, the proteid in the mixture will be about $1\frac{1}{3}$ per cent. ; this is a little too low, but it must be recollected that the proteids of cow's milk are less easily digested than those of human milk. Cream as sold at dairies varies in the percentage of fat which it contains from 10 per cent. to 40 per cent. ; when in the case of delicate children accuracy is desirable, the fat may

be estimated at a laboratory. A sufficiently exact 10 per cent. cream can be prepared domestically by allowing a quart of fresh whole milk to stand in a quart measure for six hours : the upper eight ounces will consist of 10 per cent. cream ; or, if more exact proportions are desirable, a separated (centrifugalised) standardised cream can be obtained from most of the large dairies. By dilution of one to two the proportion of sugar in milk is reduced to about one-fourth of the required amount. A little is replaced by the added cream ; the remainder can be made up with lactose.

Although the proportions of the chief ingredients can be thus adjusted, one difference will remain—viz., the comparatively high percentage of caseinogen (coagulable proteid). The digestibility of the proteids can be increased by the use of

Fig. 311.—Soxhlet's Milk Steriliser.

citrate of sodium in doses of one grain to each ounce of the prepared food. This salt possesses the useful property of lessening the coagulation of all forms of albumen.

A modified milk suitable for the first week of infant life may therefore be made up as follows :

Whole milk	5 oz.
Water	15 oz.
Cream (10%)	2½ drs.
Lactose	2 tablespoonfuls.
Citrate of soda	20 grs.

The pint of food thus prepared is sterilised before use by one or other of the methods just described. The most convenient apparatus is that of Soxhlet (Fig. 311). During its first month of life the infant requires six feeds in twenty-four hours. Into each of the bottles provided sufficient of the feeding mixture is poured to make one feed. All the bottles are simultaneously heated in the water-bath to the temperature desired and their mouths closed with the special rubber caps supplied. They are then removed, and as the contents of the

bottles cool the rubber caps become drawn in by atmospheric pressure, rendering them airtight. Thus the day's supply is prepared without undue trouble.

The amount for each feed during the first week is 2 ounces. At the beginning of the second week the amount is increased to $2\frac{1}{2}$ ounces. The feeds should be given every three hours in the day, and every six hours at night; after the fourth week 3 ounces can be given at each feed. The degree of concentration should be gradually raised thus: third week, milk $6\frac{1}{2}$, diluent $13\frac{1}{2}$; fourth week, milk 8, diluent 12; sixth week, milk 9, diluent 11; eighth week, milk 10, diluent 10 (in 20 ounces).

A bottle, with a large rubber teat and without tubing, should be employed; after use the bottle and the rubber teat should both be boiled for ten minutes, and kept immersed in boric acid lotion until again required.

Healthy infants with normal digestive capacity almost invariably thrive upon this method of feeding. Sometimes infants are unable to digest cow's milk, and some further modification is then required. When the infant is not satisfactorily digesting its foods the stools, instead of being of a smooth, uniform consistence, become more or less granular or even lumpy, and frequently, from fermentation, they become green in colour and acid in reaction. Looseness, or diarrhœa, usually accompanies these changes. The infant is restless, or sometimes cries after feeding, instead of falling asleep, as is the case in health. Colicky abdominal pains often occur, indicated by loud crying or screaming, in which the legs are firmly flexed on the abdomen; often the spasm of pain is relieved by the escape of flatus. In such circumstances, if the reduction in the amount of sugar in the feeds does not effect an improvement, cow's milk diluted and modified in the manner above described, and then peptonised for periods varying from ten to thirty minutes, may be used. This preparation is easily digested; however, infants gain in weight but slowly upon it, and its use for prolonged periods is undesirable. In severe cases a very useful substitute for milk may be found in a mixture of whey and cream, usually called the 'whey-cream mixture.' Whey differs from whole milk in being almost entirely free from the coagulable proteids, and in containing but a small percentage of fat. The composition of whey is as follows:

Proteid	0·86%	Salts	0·63%
Fat	0·32%	Water	93·38%
Sugar	4·90%		

The proteid elements which are most difficult to digest having been eliminated, this food is very suitable for premature or delicate infants, and may be given in the proportion of whey

FIG. 312.—Premature infant : weight 4 lbs. The skin of the face is wrinkled, and the child is crying feebly.

FIG. 313.—Full-time infant, weight 8 lbs. The outlines of the face are rounded, there are few wrinkles, and the child is crying lustily.

℥iss, cream ℥j, for each feed. The mixture must of course be sterilised.

A useful substitute for dairy milk is dried milk, which has the advantage of being easily kept clean in households where safe keeping of fresh milk is a difficulty. The successful modification of this or of condensed milk is a subject requiring considerable experience of infant dietetics. The student, therefore, must be referred to text-books by authorities on pediatrics.

Management of Premature Infants.—Premature infants are distinguished by being below the average length and weight, by deficiency of subcutaneous fat, by persistence of lanugo hair,

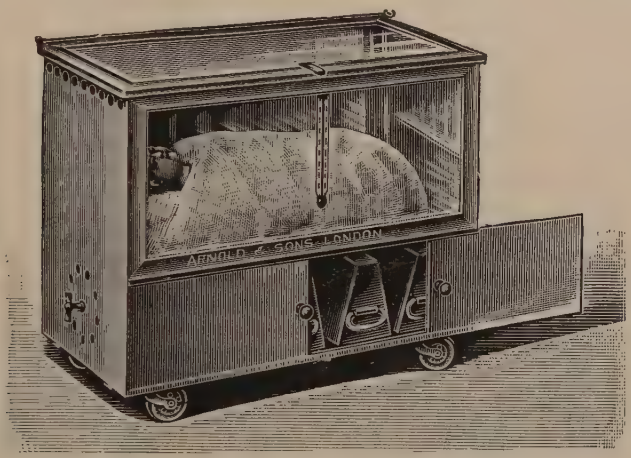


Fig. 314.—Incubator for Premature Infants.

and by a low degree of vigour as compared with the full-time healthy child (Figs. 312 and 313).

Much greater care is required in the management of an infant three or four weeks premature than of one born at full term, for prematurity implies a low heat production and indifferent digestive activity. Incubation of premature infants has been much employed, but it is doubtful whether it is really necessary, except for infants of not more than three pounds weight. The incubator generally used in this country (Fig. 314) is heated by hot-water bottles, which are placed in a closed chamber under the infant's bed ; ventilation is permitted by air-inlets, which communicate with this chamber, and exits under the roof ; a thermometer fixed to one of the glass walls enables the temperature to be kept under observation. A fairly uniform temperature can be maintained (about 85° to 90° F.), but ventilation is very imperfect, and the infant

undoubtedly suffers from want of fresh air. Experience shows that equally good results may be obtained by keeping the child in a warm, well-ventilated room (about 70° F.); the bed in which it lies should be screened from draughts, and kept at a temperature of about 100° F. by the use of hot-water bottles rolled up in blankets. The child should not be dressed in the ordinary manner, but wrapped up in sheets of cotton wool or Gamgee tissue. It should be disturbed as little as possible, and, although bathing is not advisable, the skin may be kept clean by the daily use of olive oil, with which the whole body should be freely smeared; this probably has also a certain nutritive value, some of the fat being absorbed by the skin.

Feeding may present some difficulties. It cannot be too strongly emphasised that a diet of breast milk is of outstanding importance for the successful progress of premature infants, and in the case of very premature infants its supply may call for the exercise of much ingenuity. Premature infants of four or five pounds can usually take the breast satisfactorily. When the infant's power of suction is feeble, the mother should be taught to aid the flow by expressing the milk with her fingers whilst the infant is at the breast. When the infant is too feeble to obtain any milk by its own efforts the milk must be regularly expressed or "milked" off the breast by hand and given to the infant from an easily running bottle or a spoon. It is worth while persisting with this method for a long time, because with practice the infant will improve at its task, and its powers of suction will increase in proportion to its growth. It is well to begin the feeding of a premature infant without delay, and the breast milk of another nursing mother when available is far the best food for the first two or three days. The whey-cream mixture (see p. 551) is the best artificial food for the first two or three days; of this a teaspoonful may be given every hour, until the breast secretion is available. These infants sleep nearly continuously, and must be regularly awaked for their feeds. When breast milk cannot be used, the amount of whey and cream should be increased to half an ounce every two hours by the end of the first week, when a modified cow's milk may be substituted for it. Cow's milk when used must be given more dilute—*i.e.*, with a larger proportion of water—than in the case of a full-time child, and the strength must be very cautiously increased. Sodium citrate is particularly useful in assisting the digestion of the casein. The amount as well as the concentration of the food should be kept below the usual standard. If the child cannot suck through a teat, the food should be dropped gently and slowly into its mouth through a glass pipette. Sometimes premature infants are at first too feeble to swallow, and they must then be fed through a narrow soft rubber catheter passed into the stomach.

Premature infants lose comparatively little weight during the first week, as the amount of meconium and urine which they pass is small. When no difficulties in feeding are encountered the rate at which they gain weight is often surprisingly rapid.

Digestive Disturbances.—In breast-fed babies digestive disturbances, other than those due to overfeeding, are rare when the mother is healthy, the condition of the mammary glands satisfactory, and the necessary precautions are observed in keeping the nipples and the child's mouth clean. In bottle-fed babies they are much more common, and are due either to the kind of food in use being unsuitable to the child, or to failure to observe the necessary rules of cleanliness already laid down. Digestive disturbances are indicated in infants by abdominal symptoms, such as colic, vomiting, constipation, or diarrhœa, by the parasitic eruption known as *thrush*, and by loss of weight or failure to increase in weight. *Colic* (entero-spasm) is indicated by attacks of violent screaming, in which the legs are drawn up to the abdomen; the attacks are often suddenly relieved by the passage of flatus. *Vomiting* immediately after feeding may be due to the infant having overfilled its stomach or taken its meal too quickly; when occurring a little later it may be due to the formation of tough curds in the stomach. In cases of persistent vomiting the possibility of *pyloric stenosis* must not be overlooked. This condition is characterised by attacks of vomiting, coming on about an hour after feeding, in which the ejected food is thrown out with remarkable violence, the so-called *projectile vomiting*. Even when this sign is not present, physical evidences of dilatation of the stomach may be found, the peristaltic wave, crossing the epigastrium from left to right, being fairly characteristic. *Diarrhœa* is usually accompanied by a greenish discoloration of the stools, the result of an acid fermentation, and sometimes in bad cases the stools contain fragments of undigested milk curd. It also usually causes redness and irritation of the skin around the anus, which may spread over the buttocks and inner sides of the thighs. *Thrush* is characterised by the appearance of a crop of slightly elevated, circular white spots in the mouth and throat. They are due to a fungus—*Oidium albicans*—which can be readily detected by the microscope in the scrapings from these patches. It is always accompanied by some or all of the symptoms of disturbed digestion. On inquiry the condition can usually be traced to the use of dirty bottles or teats. Wasting from unsuitable feeding must be distinguished from that due to constitutional conditions such as syphilis.

Constipation is one of the commonest disturbances of the alimentary system in infants. It may be due to underfeeding, to the abuse of purgatives and enemata, to previous attacks

of vomiting or diarrhœa, or commonly to loss of fluid by excessive sweating. In the case of breast-fed babies constipation may be due to a deficient supply of milk ; this can be verified by ' test-feeds ' and corrected by supplementary feeding in the manner already described. Purgatives such as castor oil should not be given to infants during the first week of life merely because of delay in voiding the meconium. Nothing should be done to interfere with the development of the normal reflex mechanism of defæcation, and accordingly glycerine suppositories and enemata should also be avoided at this period of life. Constipation which cannot be treated by modifications in diet may require the use of some tonic purgative, such as cascara, which may be added to a petroleum emulsion. Useful formulæ are the following :—

Petrolei liquidi puri	℥ 10
Pulv. acaciæ	gr. x.
Elixir glusidi	℥ ½
Ol. amygd. amar	℥ $\frac{1}{30}$
Aq. cinnamoni ad	ʒj
or	
Elixir cascar. aromat.	℥ iss
Tinct. nucis vom.	℥ ½
Emulsio petrolei ad.	ʒj

(Pritchard.)

The prevention of constipation by proper management is of prime importance, and much may be done by an intelligent nurse to train an infant during the first month to evacuate the rectum at regular intervals.

In general, digestive disturbances are to be treated not so much by drugs as by regulation of the quantity and quality of the food, and by strict attention to cleanliness. A common error in artificial feeding is giving the food in a too concentrated state ; no rule will apply to every case, and increased dilution may often be advisable even when the food is apparently not too concentrated. The poor often administer starchy food to very young infants ; this is quite unsuitable, for the amylolytic digestive ferments are undeveloped in the infant. Another common error is the use of *patent foods* for infants ; these are all deficient in fat, which is one of the most useful elements of an infant's food. Barley-water or rice-water may be used instead of plain water for diluting the milk in digestive disturbances. If the child does not thrive on cow's milk prepared in the manner described, a wet-nurse or a supply of ' humanised ' milk should be obtained instead. Diarrhœa is best treated by a single dose of a mixture of castor oil ʒss with olive oil ʒiss, followed by a reduction in food. Severe cases of diarrhœa with vomiting may be treated as follows : a teaspoonful or two of boiled water (warm) every hour for twelve hours ; then a teaspoonful of whey every hour for

twelve hours ; then two teaspoonfuls of the whey-cream mixture every hour for twelve hours. Thrush needs no special treatment beyond the cleansing of the mouth with boroglyceride, and attention to the food and to the condition of the bottles and teats.

Acute gastro-enteritis may result from persistence in unsuitable feeding, or from infection of the alimentary canal by contaminated milk. It is almost unknown in breast-fed babies. It is one of the most serious disorders of early infancy, and is attended by a high mortality. The chief symptoms are persistent vomiting and diarrhœa, with collapse, indicated by coldness and cyanosis of the face and limbs. There is usually great irritation and some excoriation of the skin of the buttocks, and general cutaneous eruptions of varied types and distribution are often present. The treatment is, in the first place, to stop the administration of food entirely for twenty-four to forty-eight hours and to irrigate the colon at a low pressure through a soft catheter passed for several inches into the bowel ; during this period sterile saline solution may be injected under the skin, with strict antiseptic precaution, in quantities of about 10 ounces every three or four hours. Then boiled water or albumen water in small quantities should be given, and if a wet-nurse cannot be obtained, the whey-cream mixture may be cautiously tried, or well-diluted peptonised cow's milk.

Obstetric Injuries and Diseases of the New-born Child

The new-born infant may suffer from injuries received during labour or from diseases acquired during pregnancy, and many infants die shortly after birth from these causes. By the *infant mortality rate* is meant the death-rate of infants during the first year of life, and it is calculated on the number of deaths under one year of age per 1,000 live births in that year. The infant mortality rate has actually been halved during the present century (from 154 per 1,000 in 1900 to 77 per 1,000 in 1922) ; but the number of deaths during the first month of life (*neonatal mortality*) has shown a very small decline. Nearly one-half of the deaths during the first year of life occur during the first month, and nearly one-half of the deaths during the first month occur during the first week. A large proportion of this early mortality is due to obstetrical causes.

Injuries to the Head.—The injuries to the fœtal head during labour, and the mode of origin and various sites of intracranial hæmorrhage, are fully described in the section on dead-birth (p. 577). Here will be described the symptoms to which these injuries give rise in children who survive birth.

Intracranial Hæmorrhage.—Although *extensive* subdural or ventricular hæmorrhage usually results in the fœtus being born

dead, there are a few children who survive birth for a short time. These children have always been born in a state of white asphyxia from which resuscitation has usually been difficult, and they subsequently exhibit unmistakable symptoms. There are frequent attacks of cyanosis, and the respirations are irregular and shallow. Rigidity of the limbs, often with opisthotonos and trismus, is common, and there are usually generalised convulsions or localised twitchings, especially of the face and eye muscles. The sucking reflex is absent. Somnolence or coma may be a striking symptom, or there may be, alternatively, persistent restlessness and crying with all the appearances of pain. The bulging anterior fontanelle proclaims the increased intracranial tension. The cerebrospinal fluid obtained by lumbar puncture is usually bloodstained and under high tension. The life of children who show such severe symptoms is very precarious, and they seldom survive more than a few hours or days. No treatment is of any avail; lumbar puncture, by relieving tension, seldom has any appreciable effect and at the best can only serve briefly to prolong a worthless life.

In cases of *slight* hæmorrhage there may be very few symptoms beyond asphyxia at birth, occasional attacks of cyanosis during the first few days and weakness in sucking power; lumbar puncture and careful clinical examination of infants with suspicious symptoms would probably bring to light many of the slight cases. Many infants undoubtedly recover, but usually with permanent after-effects, the chief of which are spastic paralyses of the limbs (Little's disease); the mental development of such children is scarcely at all affected.

Depression and Depressed Fractures of the Bones.—These injuries usually result from the pressure of the sacral promontory upon the part of the head with which it is in contact. The indentation or depression is usually oval and spoon-shaped, or shallow and gutter-shaped; in the former the depression is deep at one end of the oval and gradually rises to the level of the general surface of the head at the other. The posterior parietal bone is therefore the one usually affected, and it is much more likely to be caused by a flat than by a normal-shaped pelvis. More rarely it is seen upon the posterior part of the frontal bone, as a result of the lateral gliding movement of the head which occurs in natural delivery through a markedly flat pelvis (Fig. 315). It is not always easy to decide whether or not the depressed bone is also fractured. No treatment is required as a rule, for the bone gradually rises into its proper position; occasionally signs of cerebral compression occur, and then an operation to elevate it can be practised.

Fissured Fractures of the Skull.—These injuries are almost always due to difficulty in delivering the head by forceps or

version ; but they may sometimes occur after spontaneous delivery in cases of contracted (flat) pelvis. The posterior parietal bone is the one most commonly injured, and it is compressed by the sacral promontory (Fig. 317). The fracture is usually depressed and is almost always associated with severe intracranial hæmorrhage ; the infant seldom survives for long, but it may occasionally seem worth while to undertake an operation to elevate the fracture.

Cephalhæmatoma.—This minor injury is not uncommon and consists in an effusion of blood beneath the pericranium, due to

Fig. 315.—Spoon-shaped Indentation of the Right Frontal Bone. The dotted lines show the position of the anterior fontanelle.

detachment of this membrane during labour. Usually the effusion takes place gradually, and the swelling may not appear for a day or two after birth ; but it may be found on the head at birth. The cause of the separation of the pericranium is unknown ; the bone is very seldom injured, and, though usually occurring after a difficult labour, it is occasionally seen after a normal and easy delivery.

The usual situation is upon one or other parietal bone ; sometimes it is bilateral, affecting both parietal bones ; more rarely multiple cephalhæmatomata are met with. The swelling

varies a good deal in size ; it may be no larger than a walnut, when the area of detached pericranium is small ; it may, however, attain the large size shown in Fig. 316. Though limited by the sutures to the area of the affected bone because at the sutures dura mater and pericranium are united, the effusion seldom spreads over the whole surface of the bone, but is confined to a portion of it. At first it is soft and fluctuating, but soon a dense, hard, rounded edge forms around it, due to osteoplastic changes at the margins of the effusion. The blood remains fluid in the centre and is gradually absorbed, but several months may elapse before it entirely disappears. No treatment is necessary ; incision or puncture is inadvisable.

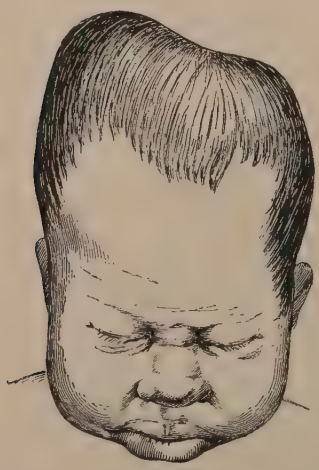


Fig. 316.—Double Cephalhæmatoma. (Ribemont-Dessaignes and Lepage.)

Injuries to Nerves. — *Facial Paralysis.*—This injury is usually caused by forceps delivery, and is due to compression of the facial nerve in the parotid region by the blade. A few cases have, however, been observed after spontaneous delivery, but their causation is quite obscure. The resulting deformity is characteristic, and consists in an extreme lateral asymmetry of the face. On the paralysed side the eye remains open, as the orbicularis is paralysed ; the naso-labial fold is obliterated ; the mouth is open. Owing to the action of the unaffected muscles being unopposed, the mouth is drawn over to the sound side ; the naso-labial fold on the same side is deep. When the child cries extreme asymmetry is produced. Suckling and deglutition are not affected. Often a skin abrasion can be seen below the zygoma on the affected side, indicating where the tip of the forceps blade has caught the nerve. As a rule, the nerve recovers spontaneously in a day or two ; but severe cases may be met with in which a certain amount of paralysis persists, and local electrical treatment will then be necessary.

Paralysis of the Arm.—(*Duchenne's or Erb's Palsy*).—This is due to overstretching of the brachial plexus or of the nerve-roots which supply it. The paralysis is usually of the upper arm type, affecting the muscles supplied by the fifth and sixth cervical nerves, viz., the deltoid, subscapularis, spinati, flexors of the elbow and supinators of the forearm. The injury is much commoner after head than after breech presentations,

Traction on the neck with deviation of the head away from one shoulder, during the difficult delivery of large shoulders, of necessity puts strain on the upper cords of the plexus, and is the commonest cause of the injury. Much the same direction of traction may occur during a difficult extraction of the after-coming head. Direct pressure with the tip of a forceps blade is only an exceptional cause. The arm hangs down limp, and is kept close to the body and rotated inward. Treatment consists in bandaging the arm across the chest over cotton wool, in which position the muscles are relaxed; after a fortnight

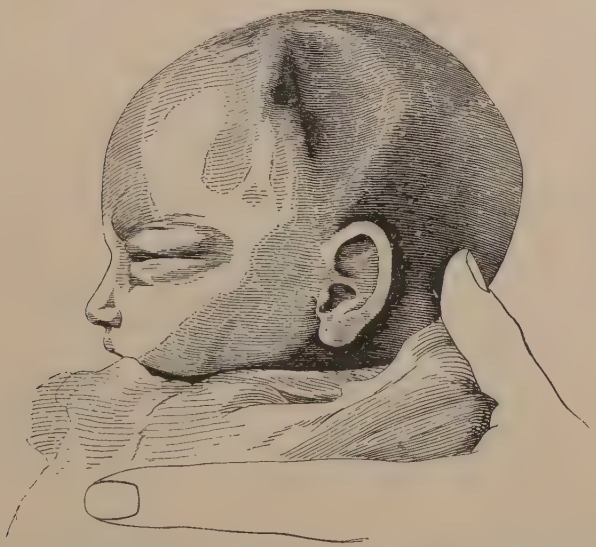


FIG. 317.—Depressed Fracture of the Left Parietal Bone caused by Labour in a Flat Pelvis. (Bumm.)

daily massage and passive movements must be employed, and later on electrical treatment may be required.

Fractures of Limbs result from unskilful delivery; they may occur in breech presentations, in delivering the legs, or from difficulty in freeing extended arms, or in head presentations when there is difficulty in disengaging the shoulders. The bones most commonly fractured are the cla icle and the humerus; fractures of the femur are unusual, but may be caused by traction on the groin.

Umbilical Sepsis.—Septic infection through the navel may occur when the cord is divided, during the process of separation, or subsequently. Some authorities consider that it is a frequent occurrence, and is responsible in one form or another for about 10 per cent. of the mortality among infants under one month old. This opinion is based mainly upon the results of autopsies,

which frequently show internal evidences of sepsis in cases in which its existence was not suspected during life. Local signs of septic infection of the navel may be seen in erysipelatous inflammation of the skin, sloughing or suppuration at the line of demarcation, often accompanied by hæmorrhage, or a sloughing condition of the ulcer left when the cord has come away. In addition to these obvious local appearances, septic arteritis and phlebitis may occur, which spread rapidly up the abdominal portion of the umbilical vessels without giving rise to noticeable external changes. Such cases usually terminate in general dissemination of the septic process by embolism. In

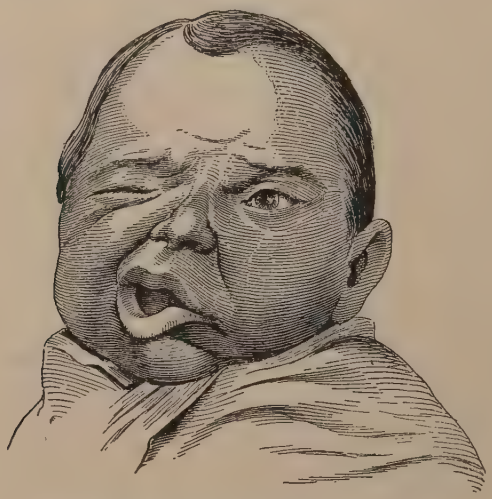


Fig. 318.—Facial Paralysis in the New-born Child. (Budin.)

tetanus neonatorum, a very rare affection, the organisms probably enter at the navel.

The only effective treatment is prophylactic. The cord must be treated systematically with proper surgical cleanliness, and the infant should be sponged, not bathed, until the cord has separated and the umbilicus has healed.

A mild form of sepsis is when the cord undergoes moist gangrene, with offensive odour, instead of dry gangrene ; it is best treated by frequent dressings to the stump of gauze soaked in alcohol.

Ophthalmia Neonatorum.—This condition begins as an acute purulent conjunctivitis, but may go on to attack the cornea, when it may result in partial or total permanent blindness from opacity, or complete disorganisation of the eyeball from perforation of the cornea may occur. In a large proportion of cases of persons who have been blind from infancy, gonorrhœal

ophthalmia has been the cause of their loss of sight. In 1,100 cases of blindness in children investigated by Harman, 24 per cent. were due to ophthalmia neonatorum. Ophthalmia is due to infection; in very rare instances this may occur *in utero* from infection of the amniotic fluid, for such cases have been recorded; in the great majority, however, the infection occurs during or immediately after labour; in a smaller but quite definite proportion it occurs in the first few days of extra-uterine life. It is probable that infection immediately after birth is due to particles of vaginal discharge which cling to the eyelids or eyelashes, and gain access to the conjunctival sac when the eyes are first opened. In normal labour the eyelids are tightly closed and probably watertight during the birth of the head, but in face presentations or in delivering the after-coming head the eyes may be infected by the examining finger. In about 60 per cent. of cases the infection can be proved to be gonorrhœal by the discovery of gonococci in the pus; in the remainder various organisms have been found, including bacterium coli, pneumococcus, Klebs–Löffler's bacillus, and the pyogenic micrococci. Gonorrhœal cases only occur by direct infection from the maternal passages. Other organisms, not derived from pre-existing disease of the maternal passages, may also obtain access in the same manner. A certain proportion of the non-gonorrhœal cases are probably of a simple catarrhal nature. Complications such as keratitis are very much rarer in non-gonorrhœal than in gonorrhœal cases.

The signs of ophthalmia make their appearance during the first four days of life in from 50 to 80 per cent. of all cases; very few cases arise later than the first week. Gonorrhœal cases begin earlier than other kinds, because infection is early, and possibly because the period of incubation of the gonococcus is short. The conjunctivæ become greatly injected and excrete a free purulent discharge; the eyelids become reddened and œdematous, and, from spasm of the orbicularis palpebrarum, distension of the conjunctival sac with pus occurs. On gently separating the eyelids the discharge will escape in large quantities. Usually both eyes are affected, either simultaneously or consecutively; when one eye at first escapes it is difficult to preserve it from subsequent infection.

Treatment.—Ophthalmia has been almost entirely banished from lying-in hospitals by the routine employment of prophylactic treatment. This consists in bathing the eyelids immediately after the head has escaped from the vulva with an antiseptic lotion, such as 1 in 4,000 perchloride of mercury, and the subsequent instillation into the conjunctival sac of one or two drops of a 1 per cent. solution of nitrate of silver. The efficacy of silver salts in destroying the gonococcus is well known, and their employment in this connection is of course a prophy-

lactic for this organism only. The vegetable salts of silver, such as argyrol and protargol, are not so efficient in prophylaxis as the nitrate of silver. Owing to the difficulty of efficiently treating ophthalmia in infants and the serious risks of blindness which attend it, the use of this prophylactic in all suspicious cases is to be advised. Some disadvantages attend the instillation of silver nitrate—viz., a slight conjunctivitis is often set up by the solution, even when there has been no infection, and occasionally keratitis ensues, which may lead to corneal opacities. Routine anti-gonorrhœal prophylaxis is unnecessary in private practice, but it would of course be indicated by direct evidence, or by suspicion of gonorrhœa in the mother.

Active treatment consists chiefly in frequently irrigating the conjunctival sacs with warm saturated boric lotion or saline solution, and the instillation once a day of silver nitrate or protargol solution. The highly infectious nature of the discharge must be borne in mind, and the child must accordingly be put in the charge of a separate nurse, to whom the risk both to herself and others should be fully explained. In severe cases the advice of an ophthalmic surgeon should be obtained.

Icterus Neonatorum.—Jaundice occurs in the new-born child under three different conditions: first, it may be due to the normal hæmolytic changes which occur in the liver and other organs; secondly, it may be due to congenital stenosis of the bile-ducts; thirdly, it may be infective and due to umbilical sepsis or some form of intestinal intoxication. The first variety is unimportant; it is most marked in premature or debilitated infants, and disappears spontaneously without treatment; the urine does not contain bile acids or salts, nor are the stools decolorised. The second and third varieties are almost necessarily fatal; the third is sometimes epidemic in character.

Gastro-intestinal Hæmorrhage: Melæna Neonatorum.—This rare but serious disease of the new-born child probably occurs in about 1 in 1,000 births. The prominent symptoms are vomiting of blood and the passage of blood in the stools; the latter varies in amount from a microscopic quantity up to a steady trickle of blood through the anus. The gravity of the condition is shown by the statistics of Townshend and others, the mortality being approximately 50 per cent.

In many cases the first symptom is hæmatemesis which may occur before the first feed has been given; in the majority of cases the initial symptoms appear in the first forty-eight hours; after the first week very few cases have been recorded. Slight bleeding *per anum* may be overlooked while the meconium is being discharged, unless care is exercised. In many cases the bleeding is not limited to the gastro-intestinal canal, but other

mucous surfaces such as the mouth and nose may be affected. Not infrequently subcutaneous ecchymoses also occur. The effect of loss of blood on the young infant is very serious, and in severe cases the child dies of anæmia within two or three days of the beginning of the disease.

The *causation* is obscure, but there are good reasons for regarding it as septic in origin; the point of entrance of the organisms may be the cut umbilical cord, or an abrasion on an exposed mucous surface, for example in the mouth or nose. Another possible point of entrance may be the small intestine, in which mucous erosions may be formed by the action of the acid gastric contents when feeding and digestion first begin. A general septic toxæmia is not infrequently associated with bleeding under varied conditions.

The *treatment* consists mainly in supporting the infant's strength with subcutaneous injections of normal saline; the amount given must be small—2 to 4 ounces—and very careful antiseptic precautions must be observed. Drugs are of little use, but recently treatment with blood serum or with whole blood has yielded most encouraging results. The subcutaneous injection of whole blood is now claimed to be a specific for this grave condition. From 10 to 20 c.c. of blood are drawn from a vein of the mother with a serum syringe and injected without delay beneath the sterilised skin of the infant; the best site for injection is in the mid-scapular line, the needle pointing outwards towards the axilla, and the injection should be made deeply into the subcutaneous tissues. The blood acts by raising the coagulability of the infant's blood.

Infantile Syphilis.—The early recognition of infantile syphilis is of such importance that the matter must be briefly referred to; for a systematic account a text-book of Diseases of Children should be consulted. A syphilitic infant is often premature, and even when born at term is usually under-sized. The skin is often of a brownish colour, and wrinkled from deficiency of subcutaneous fat; sometimes, however, the child appears to be quite healthy when born. In a few days some or all of the following signs may appear: (1) skin-cracks (rhagades) at the corners of the mouth; (2) nasal catarrh (snuffling), which sooner or later is accompanied by a watery discharge; (3) an eruption on the buttocks, at first dull red and later coppery in colour, and tending to spread in a papular form down the legs; (4) loss of weight. It must be remembered that simple nasal catarrh from cold often occurs in infants: therefore snuffling does not necessarily indicate syphilis; and the eruption on the buttocks at first resembles that due to diarrhœa. Any combination of the above conditions justifies careful inquiry for syphilitic taint in the parents, and Wassermann's reaction may be employed to confirm the clinical diagnosis both in the child

and the parents. The treatment consists in administering grey powder in doses of half a grain twice or three times a day; infants tolerate mercury well, and rapid improvement usually follows. The importance of treating both the parents of a syphilitic infant has been already repeatedly mentioned.

Part VII

INJURIES, DISEASES AND DEATH OF THE FŒTUS

The student should clearly distinguish between a *fœtus* and an *infant*. Fœtal existence is intra-uterine existence and is maintained by placental respiration, whereas infant existence is extra-uterine or independent existence and is maintained by pulmonary respiration. A fœtus becomes an infant as soon as it has breathed, or, more precisely, as soon as its existence depends on the oxygen obtained from the lungs and not on that obtained from the placenta. The transition from fœtus to infant is to be regarded as a metamorphosis which is determined by the establishment of pulmonary respiration.

By a *viable fœtus* is meant a fœtus of such a stage of development that after birth it is capable of maintaining an independent existence. Practical experience shows that the fœtus is, with very few exceptions, too feeble and immature to survive its birth if it is born before the end of the twenty-eighth week of pregnancy. The age of viability is therefore taken as twenty-eight weeks. Fœtuses of this age measure 35 cm. from the crown of the head to the sole of the heels, the body being fully extended ; this length may be taken as a trustworthy criterion of viable age in the absence of menstrual data.

Fœtal existence, in relation to its environment, passes through three stages : (1) in the quiescent uterus, during pregnancy, a long *ante-natal* stage ; (2) in the active uterus, during labour, a short *intra-natal* stage ; (3) after birth, a transient but variable *post-natal* stage, before the occurrence of pulmonary respiration announces that fœtal existence has ended and infant existence has begun.

The stage of *post-natal fœtal existence* deserves careful notice. In most cases it is momentary ; pulmonary respiration is established almost simultaneously with birth, and the fœtus becomes an infant directly it is born. But the advent of pulmonary respiration may be delayed, even after a normal labour ; it is commonly delayed when there has been much head-compression during labour, as after a breech or a difficult forceps delivery. It may be delayed for as long as twenty minutes or more when the activity of the respiratory centre has been depressed by the administration of morphia to the mother

during labour (as in morphia-scopolamine narcosis). In such cases it may be supposed that the fœtus is able to maintain existence by the reserve store of oxygen in its tissues, for its oxygen requirements are small. When the onset of respiration is delayed the fœtus is said to be in the condition of "asphyxia neonatorum," fully described below.

Fœtal Death.—The fœtus dies when its heart ceases to beat. Death may occur at any of the three stages of fœtal existence: (1) Death during pregnancy—*ante-natal fœtal death;* these fœtuses are born in a macerated condition. (2) Death during labour—*intra-natal fœtal death;* the heart is not beating at birth. (3) Death after birth—*post-natal fœtal death;* at birth the heart is beating and continues to beat for a variable period before death occurs; there is no attempt at respiration and *the fœtus dies as a fœtus, not as an infant.* It is important to understand this, for otherwise the student will be unable to appreciate the difference between a "live-birth" and a "dead-birth."

Definitions of "Live-birth" and "Dead-birth."—A *live-birth* is the birth of a viable fœtus which having been completely born makes pulmonary respirations. Pulmonary respiration is therefore the sign of live-birth. A fœtus, having breathed, becomes an infant, and is thenceforth counted as a member of the population. Even if death occurs after a few gasps have been made, a death-certificate is required, and the death will be registered and will go into the statistics of infant mortality.

By *dead-birth* is meant the birth of a viable fœtus in which pulmonary respiration does not occur; such a fœtus may either be born dead, *i.e.*, absence of heart-beat (ante- and intra-natal death), or may be born with its heart beating but dies before it has breathed (post-natal fœtal death). Absence of pulmonary respiration is therefore the sign of dead-birth. Heart-beat alone, in such fœtuses, is not a sign of live-birth, but is merely the lingering continuation after birth of intra-uterine existence under extra-uterine conditions. Dead-births are not registered in this country and do not therefore enter into the statistics of population. They must, however, be notified according to the Notification of Births Act, 1907; this Act imposes on doctors and midwives the duty of notifying to the medical officer of health all births, both live and dead, occurring after the twenty-eighth week of pregnancy. The term "still-birth" is often used synonymously with "dead-birth." The word "still" literally means absence of movement at birth, and is really descriptive of the stage of post-natal fœtal existence, in which the fœtus is born alive but makes no voluntary muscular or respiratory movements; "still-birth" is therefore more applicable to the condition of "asphyxia neonatorum."

Asphyxia Neonatorum (still-birth).—Asphyxia, which literally means *pulselessness*, has come by usage to mean interruption

of the respiratory function and is now used in this sense only. "Asphyxia" in the new-born fœtus implies that pulmonary respiration is not established at birth. The sign of intra-uterine existence (*i.e.* heart-beat) continues, but the fœtus makes no attempt to breathe and thereby to acquire an extra-uterine or independent existence.

Respiration, as it is found in the fœtus *in utero*, consists in a gaseous interchange between the fœtal blood and the maternal blood effected through the placenta. Therefore anything which causes interruption, partial or complete, of the placental circulation, either fœtal through the villi, or maternal through the intervillous spaces, will tend to induce intra-uterine asphyxia. The following conditions may accordingly cause it : (*a*) *premature detachment of the placenta* (ante-partum hæmorrhage) ; (*b*) *compression of the cord* (cord prolapsed, or tightly coiled round the fœtus, or compressed by the after-coming head) ; (*c*) *tonic uterine contraction*, causing continuous compression of the placenta. These conditions may all be complicated by *blocking of the fœtal air-passages with fluids from premature respiration in utero*, due either to cutaneous stimulation (breech cases), or to partial interference with the placental circulation, which, by causing accumulation of carbonic acid in the blood, stimulates the respiratory centre before paralysing it. Fœtuses the subjects of these complications are born wholly or partially asphyxiated. If the air-passages are clear pulmonary respiration can usually be established; if the air-passages are blocked this will be very difficult.

Apart from intra-uterine suffocation, failure to establish the pulmonary respiratory function after birth may be due to (*a*) *head injuries* and *cerebral hæmorrhage*, causing interference with the action of the respiratory or vaso-motor centres in the medulla and (*b*) such rare *congenital defects* as stenosis of the trachea or the pulmonary artery. Obviously cases may be met with in which the causation is complex—*e.g.* blocking of the air-passages with fluids may be associated with injury to the head received in difficult labour.

The asphyxial phenomena in new-born fœtuses will depend in the main upon the extent and duration of the interference with the placental circulation which has preceded delivery. The beginning of the process of asphyxia is characterised by cyanosis and high blood-pressure ; this phase is commonly known as *cyanotic* or *blue asphyxia*. Later on the blood-pressure is reduced, the circulation fails, and the skin becomes pale ; this phase is called *pallid* or *white asphyxia*, and is, of course, more serious than the former.

Cyanotic Form.—This form of asphyxia is characterised by the deep blue or purple tint of the skin, and by other appearances suggestive of suffocation—*e.g.* half-opened eyelids and

injected conjunctivæ ; there is also slight muscular rigidity of the limbs, with preservation of the cutaneous reflexes. The heart usually beats vigorously, and its movements can be readily seen and felt through the chest-wall ; sometimes in more severe cases only feeble cardiac movements can be detected.

Pallid Form.—In this form the skin is blanched, the limbs are flaccid from complete loss of muscular tone, the eyes closed, the pupils dilated, the umbilical cord is pulsating slowly and feebly, and the cardiac movements are feeble. All the reflexes, superficial and deep, are lost, the sphincters often being relaxed so that meconium escapes.

In both forms the fœtus makes no voluntary movements ; hence the time-honoured name of *still-birth* applied to the condition.

The probability of the fœtus being born in a condition of asphyxia may be sometimes foretold during labour ; thus direct evidence of *fœtal distress* may be afforded by slowing and enfeeblement of the fœtal heart-sounds, or by the passage of meconium in cases other than breech presentations. If, in

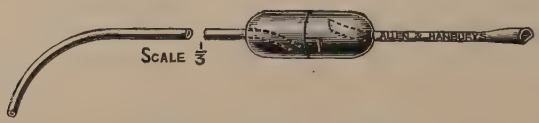


FIG. 319.—Mucus Catheter.

the intervals between the uterine contractions, the rate of the fœtal heart-beat is found to be less than 100 per minute, the fœtus is in a state of impending or early asphyxia, and its delivery should if possible be hastened by forceps or other means if its life is to be saved. In breech presentations, difficult forceps cases, and cases of antepartum hæmorrhage, there is always an increased risk of asphyxia. Accordingly, under all such circumstances, preparations for resuscitation should be made before delivery.

Treatment.—The first step is to clear the mouth and throat of fluids ; this may be done by laying the fœtus on its side and wiping out the throat with a piece of gauze wrapped round the little finger, or by holding it up by the feet for a moment or two so as to allow retained fluid to escape from the throat. In a case of cyanotic asphyxia attention may then be solely directed to exciting the respiratory centre ; in a case of pallid asphyxia cardiac is quite as important as respiratory stimulation. The treatment of the two conditions is accordingly different.

In *cyanotic* asphyxia, when the heart beats strongly, vigorous measures may be adopted, such as sprinkling the chest with cold water ; or, while in a warm bath, cold water may be

sprinkled over its head. As the cutaneous reflexes are preserved, these measures usually produce a considerable effect upon the respiratory centre. If they fail to excite any response, artificial respiration must be at once employed. When, in this form, the cardiac pulsations are feeble at the outset, artificial respiration should be begun as soon as the throat has been cleared.

In *pallid* asphyxia the fœtus must be handled with great gentleness ; it is in a state of syncope and shock and any rough handling or exposure may kill it. The greatest care must be taken to preserve the body-heat and maintain the circulation. A useful method is to immerse the body in a warm bath (105° F.) for several minutes, holding the head clear ; by gently compressing the base of the chest between the hands, and then allowing the chest-wall to recoil, artificial respiration

Fig. 320.—Sylvester's Method of Artificial Respiration. First or Inspiratory Position.

may be practised at the same time. Cutaneous stimulation of the respiratory centre is impracticable as well as dangerous, for the cutaneous reflexes are lost, and accordingly artificial respiration should be begun with as little delay as possible.

Methods of Artificial Respiration.—While many may be practised upon the adult, only three are of practical importance in the case of the new-born fœtus. Before beginning artificial respiration it is necessary to be quite sure that the pharynx and larynx are free from mucus. This is effected by sucking out the mucus with a catheter ; any form of catheter will serve the purpose, but the most suitable is one with an arrangement by which the mucus is caught in a trap instead of being sucked into the operator's mouth (Fig. 319). The left forefinger is passed to the back of the tongue of the fœtus and the catheter guided along it.

(1) *Sylvester's Method.*—The fœtus is laid on its back, a pillow being placed beneath the shoulders, and the head allowed to hang over the end in a position midway between flexion and extension. If necessary the body may be kept warm by placing beneath it a hot-water bottle well protected in a blanket. The tongue should be pulled out with the corner of a handkerchief, and an assistant is required to hold the feet steady (Fig. 320). The arms are then seized by the elbows and gently but firmly carried round by an upward and outward sweep until they lie at the sides of the head (inspiration) ; next the arms are pressed against the chest-wall (expiration) (Fig.

Fig. 321.—Sylvester's Method of Artificial Respiration. Second or Expiratory Position.

321). These movements are made at about the rate of twelve or fifteen per minute.

(2) *Tongue Traction.*—By seizing the tip of the tongue in the corner of a handkerchief, and pulling it firmly forwards, traction is made upon the larynx, and this powerfully excites the respiratory centre ; a distinct gasp often follows immediately. By repeating traction at regular intervals respiration may be maintained in favourable cases. This reflex is often preserved after all the cutaneous reflexes have been lost, but in bad cases of pallid asphyxia it may fail entirely. This method can conveniently be employed along with Sylvester's method, or while the infant is in the warm bath.

(3) *Insufflation.*—This method is only required when the air-passages have become waterlogged by premature respiration *in utero ;* great difficulty may then be experienced in

causing the air to enter the lungs by the methods of artificial respiration just described. Insufflation may be practised by the mouth-to-mouth method, or by catheterisation of the trachea. The former is not to be advised, for the greater part of the air blown into the mouth passes down the œsophagus into the stomach instead of through the glottis. When insufflation is indicated the latter method should be adopted. An ordinary gum-elastic catheter is the only instrument required ; in introducing it the index finger of the right hand should be passed into the throat, over the epiglottis, and the catheter directed along its palmar surface into the larynx. When carefully introduced no injury will be caused to the soft parts by the catheter. Air may be now gently blown into the trachea, and if fluid is present this will bubble up at the sides of the catheter into the mouth, and can be wiped away. When most of the

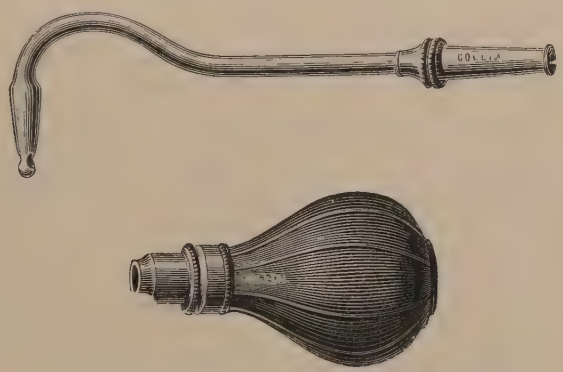


Fig. 322.—Ribemont-Dessaignes's Insufflator.

fluid seems to have been expelled, Sylvester's method of artificial respiration should be resorted to, with the catheter left in position. Used in this manner for merely freeing the air-passages, insufflation is useful. As a method of artificial respiration it is unsatisfactory, first because of the risk of rupturing the pulmonary vesicles and causing emphysema by blowing air too vigorously into them, and secondly because the air thus introduced into the lungs is exhausted air, loaded with various impurities, and consequently unsuitable for resuscitation. Ribemont-Dessaignes has invented an insufflator, by means of which atmospheric air can be blown directly into the trachea, thus neutralising the latter objection (Fig. 322).

Great care and gentleness must be exercised in carrying out the manipulations of artificial respiration. Rupture of the liver or the spleen may be caused by too vigorous compression of the trunk. While performing artificial respiration, care should be taken not to interfere with the first irregular spon-

taneous attempts to breathe which the child may make. At first long intervals occur between these attempts, during which artificial respiration must be resumed. The condition of the heart must be carefully watched. As long as pulsations can be felt in the stump of the cord or heart-beats heard with the stethoscope there is a chance of success ; when the heart has ceased to beat the fœtus, of course, is dead. In cases of pallid asphyxia after successful resuscitation the child often remains very feeble, and may die in two or three days from cerebral injury or from pneumonia—*e.g.* if fluids have been drawn into the air-passages. The prognosis after successful resuscitation is much more favourable with the cyanotic form.

The Causes of Fœtal Death.

The notified dead-births are about 3 per cent. of the live-births. This is a great waste of life and it is therefore important to consider the causes of fœtal death and its prevention.

The causes of death of the viable fœtus ("dead-birth") may be divided into two groups, *ante-natal* and *intra-natal*. In general, it may be stated that maternal, fœtal or placental disease forms the group of ante-natal causes, whereas the complications and accidents of labour constitute the intra-natal group.

Ante-natal Death.—When the fœtus dies it is usually retained in the uterus for some days before it is expelled ; being surrounded by the warm sterile liquor amnii, it undergoes a process of *maceration*. The epidermis becomes soft and sodden, bullæ containing turbid fluid form beneath it, and it peels off in patches exposing areas of dark red cutis. The entire fœtus becomes swollen and of a dusky red colour. The articular ligaments are softened, allowing free separation of the bones to occur ; the skull bones overlap and become loose, and the skull collapses. The solid viscera become soft and ultimately diffluent. The body cavities contain turbid reddish fluid. The umbilical cord is swollen and stained. The liquefaction of the tissues is due to a process of aseptic autolysis ; there is no bacterial decomposition. These changes vary in degree with the length of retention *in utero* of the dead fœtus. Peeling of the skin becomes evident after twenty-four hours ; the more advanced changes in the solid viscera and other parts require several days.

Ante-natal Causes of Fœtal Death.—These may be summarised as follows : (1) *Maternal*—syphilis, toxæmias of pregnancy, chronic renal disease, acute infections and certain other maternal diseases. (2) *Placental*—excessive white infarction (Pl. V. (3)) ; retroplacental hæmatoma (Pl. V. (1)) ; abnormally small placenta, fibrosis of placenta. The first two are usually associated with the toxæmia of pregnancy ; all give rise to "relative

placental insufficiency," by which is meant that the amount of healthy placental tissue is insufficient for the respiratory and other requirements of the fœtus. (3) *Fœtal*—primary fœtal states as causes of death are rare, for the fœtus leads a parasitic existence, and so long as the mother and placenta are healthy it seldom comes to any harm. Fœtal syphilis is included under the maternal states.

The commonest cause of ante-natal death is syphilis ; about one-third of all macerated fœtuses of viable age are syphilitic. The next common cause is the toxæmia of pregnancy, including associated placental states. In many cases of ante-natal death no cause of death can be discovered in spite of a most careful investigation of the mother and placenta, and of the fœtus itself.

The importance of examining such an important fœtal organ as the placenta in every case of fœtal death cannot be too strongly emphasised ; unless this is done a post-mortem examination of a fœtus is incomplete.

By *habitual death of the fœtus* is meant the death of the viable fœtus in successive pregnancies. This is fortunately a rare condition. It may be due to syphilis or to chronic renal disease, in both of which the death usually occurs at or near the twenty-eighth week. Sometimes habitual death is due to degeneration of the placenta. In many cases no cause can be assigned. A careful investigation of the mother (including the Wassermann test), as well as of the fœtus and placenta, should be made in order to find out the cause and to prevent, if possible, further repetition of dead-birth in future pregnancies.

Fœtal Syphilis.—The mode of infection of the ovum by syphilis has already been described (p. 172), and it was there pointed out that one of the results was death of the fœtus at about the twenty-eighth week of pregnancy ; death may occur after the twenty-eighth week, but seldom at an earlier date. After death the fœtus is usually retained for a variable length of time and is expelled in an advanced state of maceration. It is of great importance to recognise the signs of syphilis in the fœtus in order that further dead-births may be prevented by suitable treatment of the parents.

In external appearance the syphilitic macerated fœtus differs in no respect from any other macerated fœtus. On post-mortem examination there is usually notable enlargement of the spleen and liver ; neither of these is peculiar to syphilis, but their occurrence together should raise strong suspicions of the disease. The only post-mortem naked-eye change peculiar to syphilis is to be seen at the ends of the long bones, the most noticeable sites being the lower end of the femur and the sternal ends of the ribs. This is the well-known " osteo-chrondritis syphilitica " of Wegner, and consists of an inflammation of

the diaphysis at its junction with the epiphyseal cartilage, and of the cartilage itself. If the cut surface of a longitudinal section of a fresh long bone of a healthy fœtus is examined with the naked eye, a thin yellowish-white curved line will be noted running from side to side at the junction between the cartilage and the shaft; its thickness is always less than half a millimetre. In syphilitic osteo-chondritis this line becomes converted into a jagged irregular zone measuring two or more millimetres in thickness. Such an appearance may be expected to be present in 90 per cent. of syphilitic fœtuses. The appearance found naturally vary with the intensity of the condition; in a very early stage no naked-eye alteration is apparent, but microscopic sections will reveal characteristic changes.

In fœtal syphilis the *Spirochæta pallida* is present in large numbers and is widely distributed throughout the body. The most favourable sites for its discovery are the liver, adrenals and spleen; search for spirochætes may be made by the direct (dark background illumination) method or in sections stained by Levaditi's silver method. Discovery of spirochætes is, of course, absolute evidence of the disease. Characteristic changes in the placenta are found in a large percentage of cases (p. 158). The maternal Wassermann reaction is nearly always positive and the blood should be tested as a routine in every case of ante-natal fœtal death. But absolute reliance cannot be placed on the test in pregnancy or in the early days of the puerperium.

Diagnosis of Fœtal Death during Pregnancy.—The clinical diagnosis of death of the fœtus *in utero* can only be established by repeated examinations. The most reliable sign is cessation of growth of the uterus, and at least a fortnight is required to determine this with certainty, the normal rate of growth being about half an inch a week. Often an actual diminution in size from absorption of the fluid portion of the ovum, can be made out after some weeks. The uterus is usually lax and flaccid, and it is difficult to excite contractions by manipulating it. During the last three months absence, on repeated examinations, of the heart-sounds is important, but no conclusion can be drawn from failure to hear them on a single occasion. Resolution of breast-changes can sometimes be made out, and is often remarked by the patient herself. Cessation of fœtal movements will be observed by the mother, but these must not be accepted as conclusive evidence unless confirmed by other signs. It is extremely rare for a dead fœtus to undergo putrefaction *in utero*, except as the result of intra-uterine manipulation.

The treatment is expectant. Spontaneous expulsion will occur sooner or later, and there is no reason for interference except for the patient's natural desire to get her labour over.

At the same time it must be remembered that local signs of putrefaction render necessary immediate evacuation of the uterus.

Intra-natal Causes of Fœtal Death.—Death of the fœtus during labour is due either to the direct result of injury or to asphyxia. It may be said that any complication or accident of labour may result in fœtal injury or asphyxia; those especially responsible are contracted pelvis, transverse or breech presentation, prolonged labour from any cause, prolapse of the cord, difficult forceps delivery, and antepartum hæmorrhage. The fœtus is born in a fresh, as distinct from a macerated state. It may be born with its heart still beating (post-natal fœtal death). More dead-births are due to intra-natal than to ante-natal causes, the proportion of fresh to macerated dead-births being about three to two. Post-mortem examination will reveal intracranial or other injuries, or signs of asphyxia; in many cases injuries and the signs of asphyxia will be found in combination, and it is difficult to decide which was the primary cause of death. Neither injury nor asphyxia may be severe enough to cause death, as has been pointed out in the sections on "Asphyxia Neonatorum" (p. 568) and on "Obstetric Injuries and Diseases of the Infant" (p. 557).

Asphyxial Death.—When the circulation in the umbilical cord is obstructed (prolapse on pressure), or the placenta becomes prematurely separated, or the fœtus suffers from much compression during a prolonged labour, the fœtus passes into a state of *asphyxia*. Stimulation of the respiratory centre by the accumulation of carbon dioxide in the blood leads to respiratory efforts and the resultant alteration in intra-thoracic pressure causes venous obstruction and a great rise in venous pressure throughout the body. If this state lasts long enough the fœtus dies. The post-mortem signs of asphyxia are found in 40 or 50 per cent. of cases of intra-natal dead-birth. Multiple petechial hæmorrhages are present on the surface of most of the viscera, especially the lungs, heart, liver and thymus; subcapsular hæmorrhages of considerable size may be found on the liver. On section the organs appear congested and sometimes there are interstitial hæmorrhages, notably in the suprarenals. The cerebral veins are remarkably engorged and often there is subdural cerebral hæmorrhage.

Injuries.—The most important injuries causing dead-birth are head injuries. Fractures of the cranial bones due to forced delivery through a contracted pelvis are uncommon (p. 558). *Intracranial injuries*, in the form of tears of the dura mater septa (tentorium cerebelli and falx cerebri), almost invariably associated with subdural or ventricular cerebral hæmorrhage, are extremely common and are found in 40 or 50 per cent. of all cases of intra- and post-natal fœtal death. These injuries are

not always fatal, and the symptoms to which they give rise in children who survive birth have been detailed (p. 558). The mode of origin of tears of the tentorium cerebelli has already been anticipated in the description of moulding of the fœtal head (p. 270). The septa of the dura mater are to be regarded as ligaments of the bones of the vault, restraining excessive alteration in the shape of the head during labour. When the head is subjected to excessive stress the strain thrown on the septa may be so great that they tear. Plate VII is a drawing of a head from a case of labour with general pelvic contraction ; a tear of the tentorium cerebelli just below its junction with the falx cerebri will be noted. It will be observed that the effect of elongation of the head in the vertico-mental diameter is to throw considerable strain on the tentorium and falx. The blood-vessels which tear and are the usual sources of cerebral hæmorrhage are the vein of Galen and its tributaries ; considerable tension is thrown on the vein of Galen in excessive head-moulding, and the alteration in the direction of the vein will be observed in Plate VII.

Intracranial injury and hæmorrhage may be produced by any condition which causes excessive stress and extreme moulding. The most important one is disproportion between the head and the pelvis, as in pelvic contraction and excessive size of the head. The forceps is likely to cause these injuries when it is applied too early, when the force used is too great, when it is misapplied to the antero-posterior diameter of the head, and when it is used to deliver a premature fœtus. Injuries are much more liable to be caused by a quick than by a gradual compression of the head, as in cases of precipitate labour ; in breech labours the after-coming head is subjected to a comparatively sudden compression, and that is why tentorial tears and cerebral hæmorrhage are so liable to occur as the result of breech labour (p. 336). The soft and plastic head of a premature fœtus is more liable to injury than the firm head of a mature fœtus. It is a noteworthy fact that tears of the tentorium cerebelli may occur as the result of apparently normal labour.

Other injuries capable of causing fœtal death are fracture of the cervical spine and rupture of the liver. Both are rare, but have been found after difficult breech deliveries.

Fœtal deformities are an uncommon but important cause of fœtal death. Those which are of obstetrical interest, because they cause obstructed labour, have already been considered (p. 417).

Part VIII

OBSTETRIC OPERATIONS

Obstetric operations are surgical procedures, and must always be regarded as such from every point of view. Every procedure which involves internal manipulations, however simple, must be carried out with the same careful attention to technique and to antiseptic details as the more formidable ones. Minor operations are more often followed by septic complications than major operations because this principle has not received due attention. A brief description of the aseptic technique of vaginal and abdominal operations is here introduced in order that repetition may be avoided in the description of individual operations.

The Operation Area.—The technique to be followed is somewhat different in the case of abdominal and vaginal operations.

The *abdominal wall* should be prepared twelve hours before operation by shaving the pubes down to the level of the folds of the clitoris, and thoroughly cleansing with spirit-soap and water; special attention must be paid to the umbilicus. The difficulties of sterilising skin are well recognised, and some surgeons have abandoned the attempt to do so, relying solely upon simple cleansing of the abdominal wall; they regard antiseptic solutions as being ineffective for sterilisation, and objectionable from diminishing the vitality of the tissues. The majority of surgeons, however, are of opinion that the risks of skin-suppuration cannot be met except by the use of antiseptics. Our practice is, after the preliminary cleansing just described, to paint the whole abdominal surface freely with a 2 per cent. watery solution of iodine, or with tincture of iodine. The whole abdominal area, including the groins and the flanks, should be dealt with in this way. A sterile dressing is applied and the painting of iodine repeated after the patient has been anæsthetised.

The *vulva* and *vagina* present unusual difficulties to efficient sterilisation, owing to the constant presence of secretions and the proximity of the urinary and anal apertures. The bacterial flora of the vulva are abundant and varied; the dense hairy covering and the abundance of sweat and sebaceous glands place further difficulties in the way of effective sterilisation. If healthy conditions prevail, the bacteria present are probably not of great pathological significance, but in diseased conditions

pathogenic organisms of high virulence may be present, the destruction of which will be very difficult.

Vulva and pubes should be completely shaved, and the skin prepared with spirit-soap. The vagina cannot be prepared by

FIG. 323.—The Position and Coverings for a Vaginal Operation.

douching alone, although this is useful in removing secretions. Disinfection must be carried out under anæsthesia immediately before the operation is begun. The iodine method yields good results, the watery or alcoholic solution being rubbed firmly first into the vaginal walls with the aid of a speculum, and then

into the skin of the labia, perineum, and inner aspects of the buttocks and thighs.

The Isolation of the Field of Operation.—The operation area having been thus prepared as far as possible, it is important

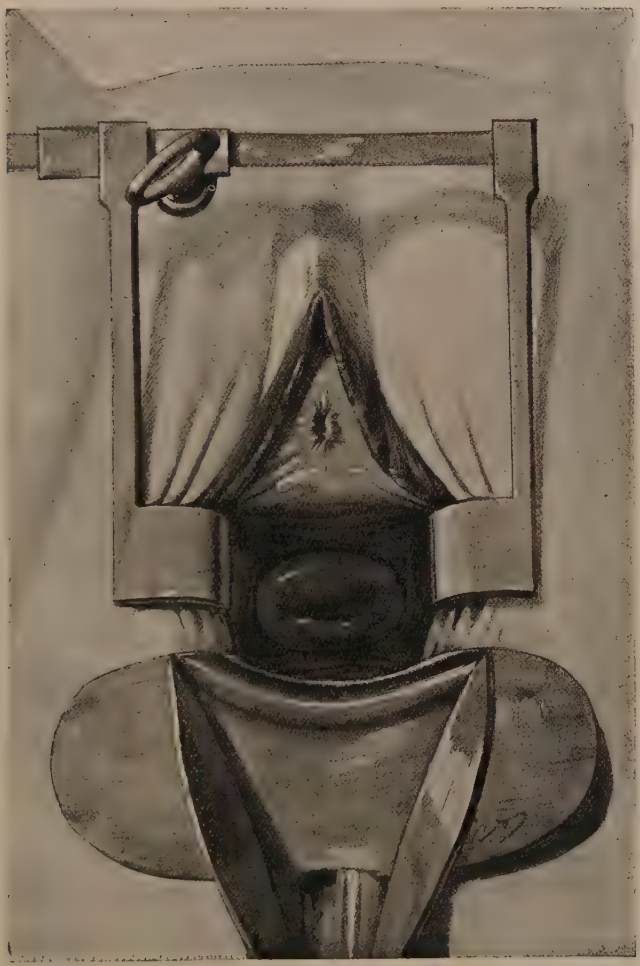


FIG. 324.—Jayle's Vaginal Retractor and Auvard's Speculum in Position.

that during the operation this part of the body should be so surrounded by sterile protective coverings that it is completely shut off from other parts of the body, or of the body-coverings. This is effected by covering up the entire surroundings of the 'field' with sterilised cloths and waterproofs. The general

arrangements are sufficiently indicated in Figs. 323 and 324, which show the patient in position for a vaginal operation. In vaginal operations it is important that the anus should be covered with a waterproof dressing fixed with stitches or clips to the surrounding skin.

FIG. 325.—Auvard's Self-retaining Vaginal Speculum. The shank of the speculum is weighted with a ball of lead, and channelled to allow of the escape of douche fluids from the vagina.

In vaginal operations necessitating exposure of the cervix and vaginal walls the arrangement shown in Fig. 324 is convenient. The two-bladed vaginal retractor of Jayle separates the lateral vaginal walls, while the weighted speculum of Auvard depresses the posterior wall and perineum. The exposure of the depths of the vaginal canal which is thus obtained enables manipulations to be carried out under direct observation, avoiding contact of instruments with skin surfaces.

Artificial Interruption of Pregnancy

It may be necessary or advisable to interrupt pregnancy either before the fœtus is viable (*induction of abortion*) or after it has become viable (*induction of premature labour*). We shall have to consider first the *indications* for interrupting pregnancy, and then the *methods* by which it may be accomplished.

A. Indications for inducing Abortion or Premature Labour

I. **Induction of Abortion.**—The conditions which may justify the induction of abortion can be divided into two groups—*general* and *local*.

(A) *General indications.*

(1) Hyperemesis gravidarum.
(2) Acute or chronic nephritis; sometimes bacillus coli urinary infection.
(3) Chronic valvular disease of the heart with failure of compensation.
(4) Advanced pulmonary tuberculosis.
(5) Graves' disease.
(6) Insanity.

(7) Diabetes, if insulin treatment is not available.
(8) Chorea when not amenable to general treatment.

(B) *Local indications.*
(1) 'Threatened abortion' with uncontrollable hæmorrhage.
(2) Vesicular mole.
(3) Retention of a dead ovum (occasionally).
(4) Infection of the uterus, as after attempted criminal abortion.
(5) Acute hydramnios.
(6) Irreducible prolapse of the gravid uterus.
(7) Extreme degrees of obstruction, when the alternative of Cæsarean section at term is refused by the patient —*e.g.*:
(*a*) Pelvic contraction of extreme degree.
(*b*) Atresia of the vagina or cervix.
(*c*) Irremovable malignant tumours, such as those of the pelvic bones, and advanced carcinoma of the cervix.

The medical profession wisely adopts a cautious attitude towards the induction of abortion. The operation is justifiable (1) to save the life of the mother; (2) to preserve her health if it is likely to be damaged by the continuation of pregnancy. Of the *general indications* enumerated above, it is apparent that the termination of pregnancy is more urgently called for in some than in others. In cases of severe hyperemesis gravidarum and nephritis the mother would probably die if pregnancy were allowed to continue; in cases of severe pulmonary tuberculosis her health would probably be irreparably damaged; and in cases of heart disease, with failure of compensation, she might die as the result of labour. It is often a matter of difficulty to decide in such cases whether to induce abortion without delay, or to do so only as a last resort after the methods of treatment described in previous sections have been found unsuccessful. Great difficulties in coming to a correct decision may arise in cases where the continuation of pregnancy may damage the health, for there are varying degrees of 'damage to health.' Medical men are often urged to terminate a pregnancy on inadequate grounds, and may be subjected to great pressure on the part of the patient or her relatives. It is advisable, before inducing abortion, that a consultation should take place between two medical men, one of whom should be of senior standing or have special knowledge, both of whom accept responsibility for what is to be done; and, to avoid all appearances of secrecy, the operation is best done in a hospital or a nursing home. In most of the *local indications* the ovum is already damaged or dead, and the life of the fœtus need not be

seriously considered ; the ethical objection to the termination of pregnancy—viz., the destruction of a potential life—does not therefore arise. A patient with an extreme degree of obstruction is quite within her rights to refuse the risk, though it is a small one, of a Cæsarean section at term ; if her medical attendant is not in ethical agreement with her, he must ask her to seek advice elsewhere.

Criminal Abortion.—It must be recollected that the induction of abortion, except for clear medical indications, is an offence against the law.

II. **Induction of Premature Labour.**—Labour may be induced prematurely with two distinct objects : (1) to save the mother when urgent complications are present ; (2) to enable the fœtus to pass without injury through a relatively narrow pelvis.

(A) *General Indications.*—Those already mentioned as indications for inducing abortion will, when encountered in late pregnancy, indicate induction of premature labour. Two important additions must be made—viz., *eclampsia*, and the toxæmic *albuminuria of pregnancy* in cases where medical treatment has failed ; these conditions are very seldom met with before the fœtus is viable.

(B) *Local indications.*

(1) Pelvic contraction of moderate degree.
(2) Post-maturity. Owing to the large size of the fœtus, pregnancy should not be allowed to go beyond 300 days.
(3) Abnormally large size of fœtus in previous pregnancies.
(4) Placenta prævia ; accidental hæmorrhage when profuse or recurrent.
(5) Hydramnios when attended with severe pressure symptoms.
(6) Premature death of the fœtus *in utero* in previous pregnancies.

Methods of inducing Abortion and Premature Labour

Many different methods are available for this purpose. The choice of a method is determined partly by the period to which pregnancy has advanced, and partly by the degree of urgency of the indication. Methods required during the earlier months of pregnancy are not suitable for the later months ; it will therefore be convenient in the first place to consider them in relation to the period of pregnancy.

During the First Three Months of Pregnancy.—During this period of pregnancy induction of abortion may become necessary from hæmorrhage (including vesicular mole), or from some serious maternal disorder, such as pernicious vomiting, nephritis,

or cardiac disease. In all such conditions it is desirable to employ a method by which the uterus can be rapidly emptied ; slow methods of induction increase the risks of septic infection, and are not so safe as rapid methods when the patient is seriously ill.

The best method is, therefore, rapid dilatation of the cervix under anæsthesia, and immediate evacuation of the uterus. It is not in all cases an easy matter to dilate the cervix of a gravid uterus, and the preliminary use of a laminaria tent may be of considerable assistance. The tent should be introduced at least twelve hours before the operation. Scrupulous attention to aseptic technique is called for when this appliance is used. The tent is sterilised by immersion for at least a week in absolute alcohol, or in 1 in 1,000 alcoholic solution of perchloride of mercury. The vulva should be shaved and the vagina and vulva swabbed freely with tincture of iodine. A duck-bill speculum is then passed, the cervix seized with a volsella, and the tent, held in the introducer, carefully guided into the cervical canal and pushed in for an inch and a half—*i.e.*, until the upper end has passed the internal os. The largest size of tent which the cervix will take should be selected. The effect of the tent is partially to dilate the cervix, and to soften its tissues so that the subsequent stages of the dilatation can be carried out without laceration.

Twelve hours later the patient is anæsthetised, the tent is removed, and the cervix is further dilated with the graduated metal dilators shown in Fig. 98. The operator should use sterilised rubber gloves, and the procedure is to be carried out in the same manner and with the same precautions as the gynæcological operation of cervical dilatation. In this manner the cervical canal should be stretched sufficiently to admit the index finger readily. This is quite large enough for the removal of a three months' ovum ; at the fourth or fifth month it may be necessary to enlarge the cervical canal still further in the manner described on p. 587. It is important that the dilatation should be sufficient to allow the finger to pass easily, for in forcing the finger through serious laceration of the cervical tissues, softened as they are by pregnancy, may occur without the operator realising what has happened.

The dilated cervix being firmly held in the grip of one or two volsellæ, the index finger is passed into the uterus, the half-hand (fingers only) being introduced for this purpose into the vagina. First the finger is used to detach the ovum from the uterine wall ; the other hand is placed upon the fundus and so used as to push down the uterine wall upon the finger in the cavity, bringing the upper part within reach. The attachments of the ovum at this period are very delicate, and are readily torn through. When the ovum has been *completely*

detached the finger is withdrawn and a pair of ovum forceps (Fig. 102) introduced into the uterus; some part of the membranes is then seized, and often the entire sac can be gently withdrawn in one piece. The fœtal tissues are very soft at this period,

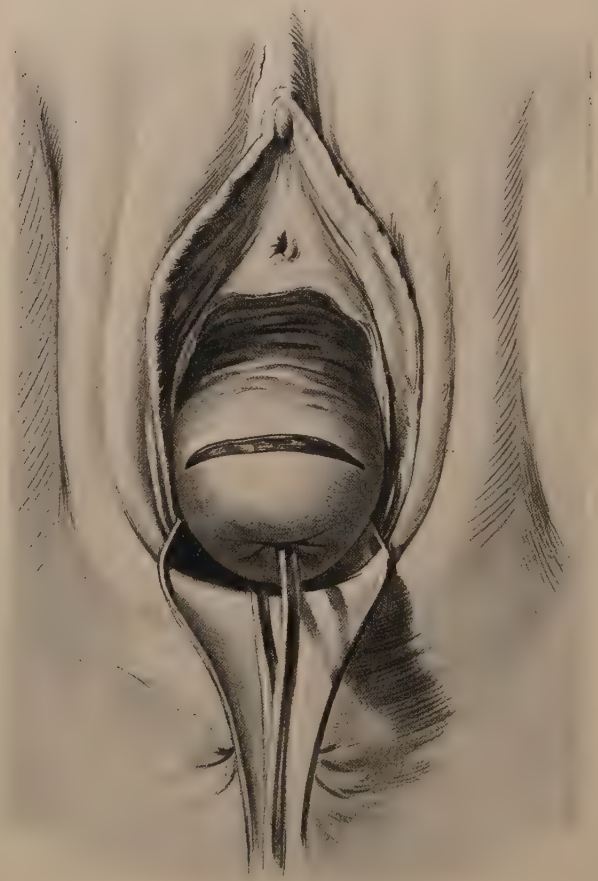


Fig. 326.—Vaginal Hysterotomy: the Incision across the Front of the Cervix at the Level of the Vaginal Insertion.

and there is no difficulty in extracting the fœtus in the same manner. Next, the finger should be again introduced and the walls of the uterus scraped with the finger-tip to detach the decidua vera; or a flushing curette may be gently used for this purpose. The decidua forms a thick bulky membrane, and its complete removal is a matter of considerable importance.

Finally, the uterine cavity should be thoroughly irrigated with a hot solution (110° F.) of a non-toxic antiseptic, such as lysol or iodine, which serves the double purpose of arresting hæmorrhage and removing small fragments of loose tissue. Finally, the uterus should be firmly massaged between the fingers in the vagina, and the other hand on the abdomen ; this will squeeze out excess of douche fluid and will cause the uterus to contract strongly, arresting all hæmorrhage. Continuance of undue bleeding is usually due to retention of a piece of membrane or blood-clot, and the finger should be re-introduced into the uterus to detect it. If difficulty is still encountered in arresting hæmorrhage the uterine cavity may be firmly plugged with bismuth or plain sterilised gauze, and an intramuscular injection of ergot or pituitrin administered. The gauze must be removed within twenty-four hours. This is the safest and simplest method of terminating an early pregnancy.

It must be recognised, however, that the operation is not free from danger. Fatal cases of uncontrollable bleeding from inertia have occurred during the performance of the operation ; serious laceration of the cervix opening up the broad ligament, and attended by serious bleeding from uterine veins, may also occur. In both these accidents, chief reliance is to be placed upon careful and accurate plugging under anæsthesia to control the bleeding. And, lastly, infection, with its serious sequels, is only too common when the operation is performed without attention to aseptic technique.

During the Second Three Months of Pregnancy.—During this period the operation required for *rapidly* emptying the uterus is more severe than in the earlier months ; alternative procedures, known as *slow methods*, may be practised when the indication is not one of urgency.

Rapid Method.—The increased difficulty arises mainly from the size of the fœtus and the greater density of its tissues ; the cervical canal must accordingly be further enlarged to allow it to be extracted without laceration of the uterus.

The operation proceeds in the manner just described up to the point at which the cervix has been dilated to the fullest possible extent with the graduated metal dilators. Further than this the cervix cannot safely be stretched ; serious laceration almost inevitably results from attempts to dilate it further. It is accordingly preferable to incise the cervix in the following manner (*vaginal hysterotomy*) : The cervix, firmly held with two pairs of forceps, is pulled down to the vulva and a transverse incision made across it, about two inches in length, at the level of the cervico-vaginal insertion—*i.e.*, immediately below the bladder (Fig. 326). The bladder is then separated by blunt dissection from the front of the cervix until the peritoneum of the floor of the utero-vesical pouch can be

reached with the finger and recognised by the slippery surfaces gliding over one another (Fig. 327). The bladder is held up out of the way with a retractor, and an incision is then made with strong scissors through the anterior wall of the cervix in the middle line, beginning below and continued upwards until

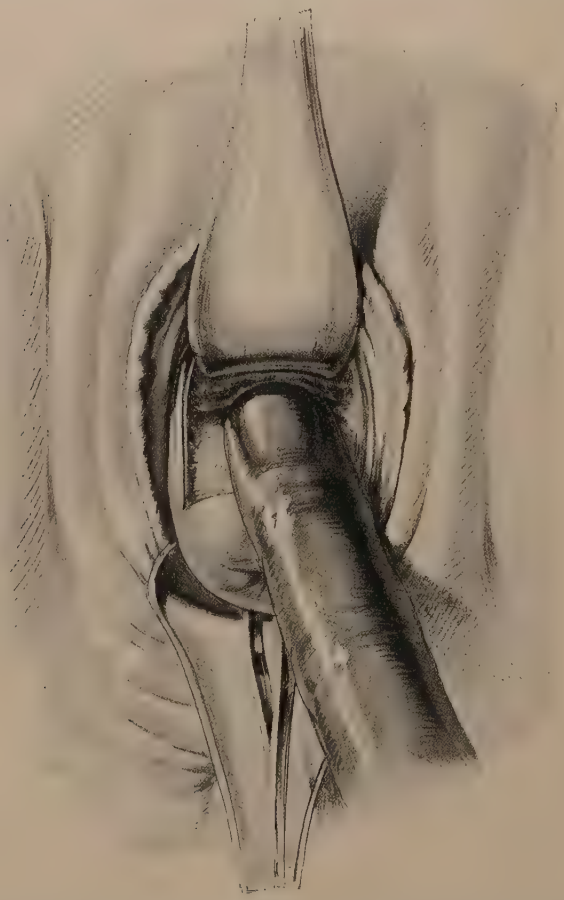


FIG. 327.—Vaginal Hysterotomy: separation of the Bladder from the Front of the Cervix. The finger is pushing up the peritoneum forming the floor of the utero-vesical pouch.

the internal os has been reached and divided (Fig. 328). By carrying the incision still further upwards the amount of room can be increased according to the requirements of the case. The membranes are now ruptured and the fœtus seized and extracted by the feet; the head can be perforated if necessary with a knife or scissors. The placenta and membranes can

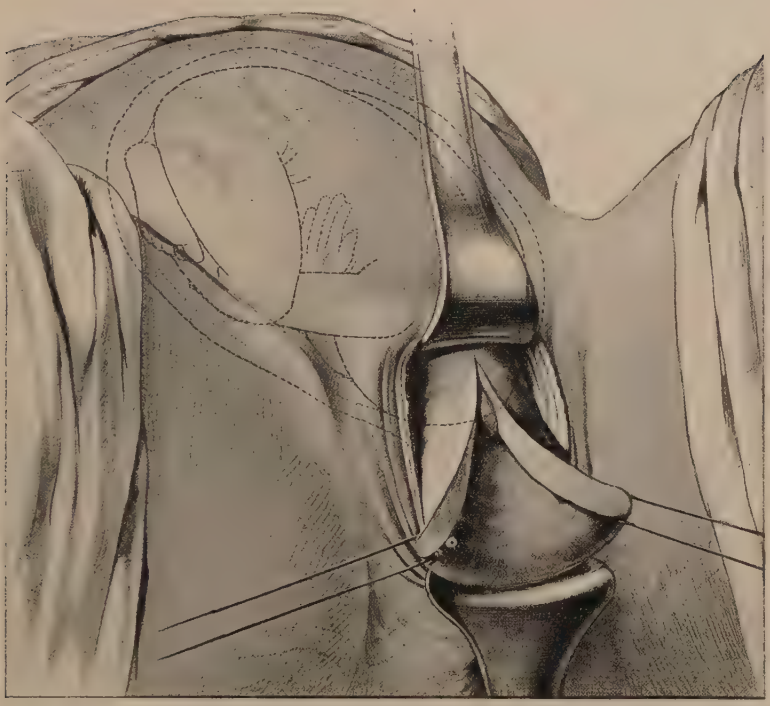


FIG. 328.—Vaginal Hysterotomy: division of the Anterior Wall of the Cervix as high as the Level of the Internal Os. The bag of waters is seen bulging through the internal os; the fœtus is represented in outline. (The fœtal outline is too large for the period—three to six months.)

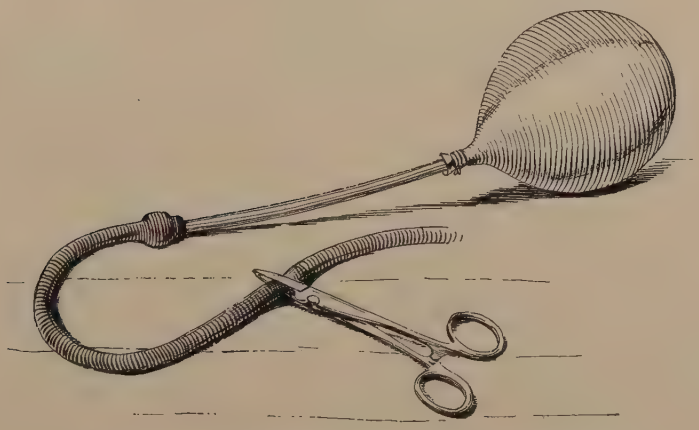


FIG. 329.—Small Hydrostatic Dilator inflated with Fluid.

now be detached and removed without difficulty. After the uterine cavity has been douched and bleeding checked in the manner described above, the incisions are closed with catgut stitches. The uterine incision can be brought well into view by drawing down the cervix with two volsellæ, while an assistant pushes down the uterus from above.

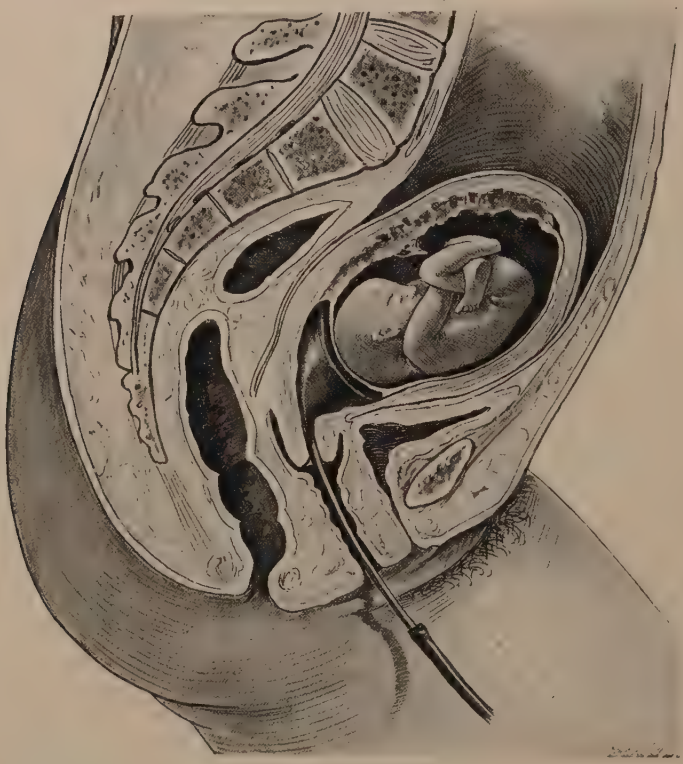


FIG. 330.—The small Hydrostatic Dilator in position in the Uterus.

Lastly, the edges of the vaginal incision are closed in the same manner.

This operation is more severe and requires more operative experience than that described above. It is precisely the same procedure as that practised by gynæcologists in removing fibroid polypi too large to pass through the undivided cervical canal.

Slow Methods.—These methods differ from that just described inasmuch as they aim at exciting the uterus to throw off its contents by a process similar to that of spontaneous abortion. It is in many cases exceedingly difficult to excite effective

uterine contractions ; considerable delay and repeated manipulations are then required, and in the end some operative procedure may be necessary to terminate the process. Thus the danger of the occurrence of septic infection is much increased.

(1) The membranes may be ruptured by the sound and dilatation begun by the use of a laminaria tent. Rupturing the membranes will not start labour pains unless it leads to a free escape of liquor amnii ; a gradual escape may continue for several days without any sign of abortion beginning. Tents are useful in softening the cervical tissues and producing a slight amount of dilatation, but are not always effective agents for exciting uterine contractions.

(2) A better method is the use of the small hydrostatic bag shown in Fig. 329 ; if the cervix is completely closed sufficient enlargement can be produced by the preliminary use of a tent, or by using uterine dilators. The instrument consists of a thin rubber bag tied over the end of a gum-elastic catheter. When deflated, it can be pushed through the internal os on the catheter without difficulty. It can be sterilised by boiling before being introduced, and inflated by injecting a measured quantity of sterilised water into it after introduction. It then lies, as shown in Fig. 330, in the lower pole of the uterine cavity. It is better not to rupture the membranes before using this dilator, as a much more definite increase in intra-uterine tension can then be obtained. The bag acts in the same manner as the larger appliance of Champetier de Ribes (see p. 594). Graduated sizes can be obtained, and when one bag has been expelled as the cervix dilates, another can be introduced.

As soon as regular contractions set in the case may be managed as one of spontaneous abortion.

During the third three months.—During this period the large size of the fœtus and the comparative density of its bony tissues render the evacuation of the uterus a much longer and more complicated process. It is advisable, in all but cases of the greatest urgency, to proceed by methods designed to excite the process of labour, which is then conducted upon general principles, and in many cases may proceed to a natural termination without further interference. In the presence of maternal complications which admit of no delay, such as certain cases of ante-partum hæmorrhage, the operations of abdominal or vaginal Cæsarean section may be practised.

The methods applicable to this period will now be described in turn, and the conditions indicated for which each is suitable.

Rupture of the Membranes.—If this procedure is so carried out as to lead to the escape of a large quantity of liquor amnii, labour follows rapidly as a rule. The slow escape of a small amount of fluid may not provoke labour for several days. Loss of a considerable proportion of the liquor amnii has a very

unfavourable influence on the course of labour (see p. 415), while the opening up of the amniotic sac permits of an ascending infection reaching the uterus from the vagina. These two objections have led to other methods being preferred to this one. In severe instances of hydramnios it is, however, the method of choice, and offers obvious advantages.

Intra-uterine Bougie (Krause's method).—This procedure consists in the introduction of one or more sterilised gum-elastic bougies into the uterus, between the membranes and the uterine wall; it is a very simple method, and requires only care and surgical cleanliness in its performance. The maternal passages must be free from infection; the method would be contra-indicated, for example, in the presence of gonorrhœal infection. The observance of strict antiseptic precautions is facilitated by introducing the bougies under anæsthesia. The bougies can be sterilised by boiling them for ten minutes; they are then transferred from the steriliser into a long glass catheter tube furnished with a rubber stopper, both of which also have been sterilised by boiling, and containing a *cold* solution of 1 in 4,000

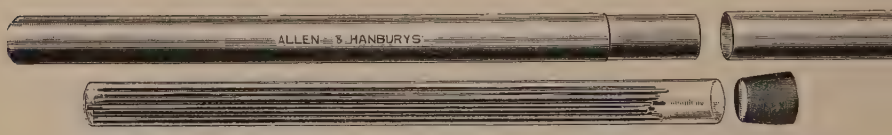


Fig. 331.—Glass Tube, Rubber Stopper, and Metal Case for carrying Sterilised Bougies.

biniodide of mercury. Boiling makes the bougies so soft and pliable that it is difficult to introduce them, and the effect of placing them at once in a cold solution has the effect of stiffening them again. In this way sterilised bougies can be carried in the instrument bag with safety (Fig. 331). The usual size employed is No. 12. The cylindrical, extra stiff pattern, twelve inches long, is the most convenient for introduction into the uterus. The introduction of the bougie will be facilitated by placing the patient in the lithotomy position. After disinfection of the vulva and vagina by swabbing freely with tincture of iodine the cervix is exposed with Sim's speculum, seized with a volsella, and its canal carefully swabbed with tincture of iodine; the point of the bougie is then guided directly into the cervix, and pushed up to the level of the internal os. The point is then directed towards the uterine wall and the bougie slowly pushed up into the uterus. The length of the bougie which can thus be passed depends of course on the size of the uterus—*i.e.*, the period of pregnancy; at or near term only about one inch will remain below the os externum. It is well to introduce a second bougie by the side of the first. The vagina should then be lightly plugged with iodoform gauze. Sometimes a little bleed-

ing occurs, but this does no harm. The bougie is often pushed through the membranes; but when this happens only a moderate amount of liquor amnii escapes if the puncture is above the level of the internal os. If any resistance to the advance of the bougie is met with, the placenta may be in the way; the bougie should then be withdrawn, and re-introduced in a different direction.

This procedure invariably provokes labour, but the time of onset of labour pains is very uncertain. It is in common use at Queen Charlotte's Hospital, where it is found that the average interval between the introduction of the bougie and the delivery of the child is seventy-five hours; occasionally labour may be complete in twelve hours, but cases have now and then occurred in which eight to ten days have elapsed. Even if labour pains do not come on, a little dilatation of the cervix sufficient to admit one or two fingers is usually produced in twenty-four to forty-eight hours. The bougies should not be removed when the pains begin, for this may cause labour to cease; they come away spontaneously with the after-birth. If labour pains do not begin in twenty-four hours, another bougie should be introduced at the opposite side; a fourth may be put in after a further twenty-four hours if required. A better plan is to rupture the membranes when the cervix has been softened and dilated sufficiently to admit two fingers, and introduce the small de Ribes's bag.

Krause's method is simple and easy, and is accordingly well suited for general use. If due attention is paid to surgical cleanliness no harm will result. The bougies usually become very soft after forty-eight hours' maceration in the uterus. If the membranes are accidentally ruptured during their introduction, it is little, if any, disadvantage if the opening so made is above the cervix, for the escape of fluid through this valvular opening is slow, and a small bag of waters is formed notwithstanding. The disadvantage of the method is the uncertainty as to when labour will begin effectively.

Hydrostatic Dilators.—Dilatation of the cervix by the introduction into the uterus of rubber or silk bags, and their forcible distension with water, is a method which has been much in vogue for many years. The small bags used for inducing abortion have been already described; only one other need be referred to—viz., that of Champetier de Ribes; the principles upon which its action is based will become clear when the instrument and the method of using it have been described.

De Ribes's dilator is a curved pyriform bag, cylindrical on transverse section, and made of strong silk, covered with india-rubber or gutta-percha (Fig. 332); it is therefore impervious and inelastic; it preserves its shape when distended, and can be sterilised by boiling. When the bag is fully distended the broad

upper end measures, in the two sizes usually supplied commercially, $4\frac{1}{2}$ inches and $3\frac{1}{2}$ inches in diameter; the curve enables it to lie accurately in the axis of the pelvic canal. When in position the broad end lies in the lower uterine segment, above the level of the pelvic brim; the lower end protrudes from the vulva (Fig. 333). To this end is attached a rubber tube, through which fluid can be pumped into the bag, with a tap to retain it there. It is not advisable to distend the bag to its utmost capacity with water, as it then becomes very rigid; it is sufficient to introduce into the larger size about fourteen ounces, into the smaller about eleven ounces. It cannot be passed through the undilated cervix; if the cervix admits one finger, the bag can be introduced under an anæsthetic; if it admits two fingers, an anæsthetic is not always required, but it is of advantage in allowing greater attention to the details of asepsis.

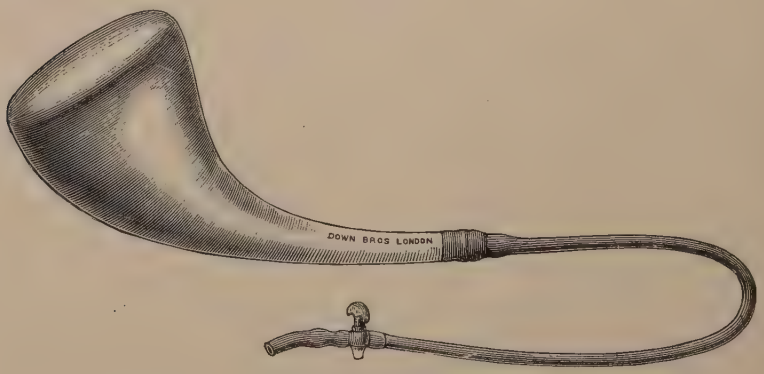


Fig. 332.—Champetier de Ribes's Hydrostatic Bag.

Therefore, when used to induce labour, it may be necessary to dilate the cervix partially by some other method, such as the use of graduated metal dilators, for which an anæsthetic is of course always necessary.

The bag must first be sterilised by boiling for ten minutes; it should be filled with water and the tap left open before being placed in the steriliser, so that the boiling water can circulate through it. Then it is immersed in a solution of 1 in 4,000 biniodide of mercury if not used immediately. The genital passages must be douched, dried, and swabbed with tincture of iodine, and the operator should, of course, wear rubber gloves. The bag is then folded longitudinally into the smallest possible bulk and held in a pair of sterilised forceps; special forceps may be obtained with curved blades (Fig. 334), but an ordinary pair of ovum forceps will serve the purpose equally well. Two fingers of the left hand are used to guide the

forceps into the cervical canal, and the *broad base* of the bag is then pushed up well above the level of the internal os. The forceps is then withdrawn, and boracic lotion (1 in 40) or boiled water pumped into the bag with a syringe ; the capacity of the bag should have been previously measured, and a quantity of fluid less than that required to fill it entirely should be injected. If the bag has not been pushed far enough into the cervix, it will escape into the vagina as it becomes distended ; if the

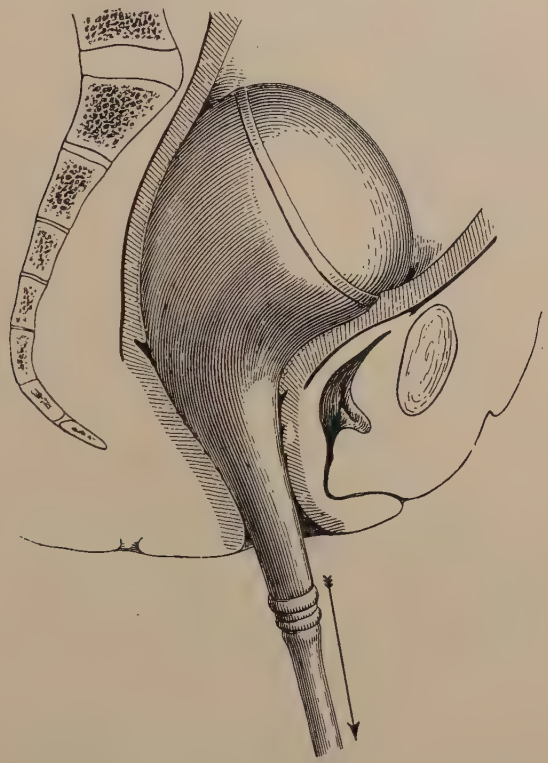


Fig. 333.—De Ribes's Dilator introduced into the Uterus. (Edgar.)

broad end lies above the internal os, its shape will prevent its escape in this manner.

De Ribes's bag, as a rule, is introduced between the membranes and the uterine wall ; when distended it therefore causes extensive separation of the membranes from the wall of the lower uterine segment. If, however, while introducing it the membranes should be accidentally ruptured, no harm will follow, for the distended bag prevents escape of the liquor amnii. An important exception to this rule is the case of

placenta prævia ; here the membranes should first be ruptured and the bag then introduced into the amniotic sac, otherwise distension of the bag will cause extensive separation of the placenta, which not only increases the risk of hæmorrhage, but also prejudices the survival of the fœtus by diminishing its sources of aeration and nutrition.

The normal mechanism of labour is closely imitated by the action of de Ribes's bag. Its curved conical shape corresponds to the shape of the dilating cervix and lower uterine segment, while its fluid consistence resembles that of the normal dilator—the bag of waters. When the membranes have ruptured, escape of liquor amnii is prevented by it. Its action depends upon its exciting uterine contractions, by which it is driven gradually down through the cervix, distending it as it passes. When the pains excited by it are feeble, dilatation can be assisted by traction on the lower end of the bag. Traction may be applied intermittently by pulling during the pains, or con-

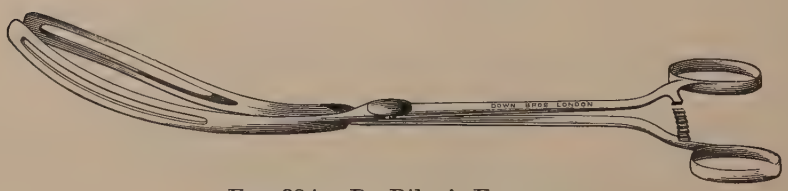


Fig. 334.—De Ribes's Forceps.

tinuously by attaching a weight of two to four pounds to the end of the rubber tube and carrying it over the foot of the bed. Ultimately the whole cervical canal is stretched to the diameter of the broad end, and any intra-uterine manipulation required to deliver the fœtus can therefore be immediately undertaken. When the broad end has been driven out of the cervix the contents may be allowed to escape, and the bag is then withdrawn. Often the uterine pains excited by it are so strong that natural delivery is quickly effected after dilatation, when the pelvis is of normal size. Sometimes, however, the pains rapidly cease when the dilator has been expelled into the vagina. In some rare cases pains are not excited by the bag at all, although with the help of traction it may dilate the cervix.

The time occupied by this method in fully dilating the cervix varies ; when employed to excite labour it takes, on an average, from twelve to twenty-four hours to obtain full dilatation ; if labour is already in progress dilatation may be completed by its use in from half an hour to two hours.

Two objections to the use of de Ribes's bag must be noticed. In the first place, there is no doubt that its presence in the lower uterine segment displaces the presenting part and may thus

disturb a favourable presentation. This objection is, as a rule, unimportant, for after the bag has done its work the condition of the passages allows of the easy correction of any unfavourable presentation. In the case of placenta prævia the objection is an important one, for violent hæmorrhage may occur when the bag has been expelled from the cervix, rendering rapid delivery urgently necessary. The occasional occurrence of rupture of the uterus when the bag has been used in cases of placenta prævia has been already referred to.

In inducing premature labour with de Ribes's bag the larger size is usually unnecessary; and it must be recollected that when the pelvic brim is much contracted there will not be room in the conjugate for the larger size. De Ribes's bag is far too large to be used for the induction of abortion, the small rubber bags previously described being preferable for this purpose.

The Castor Oil-Quinine-Pituitrin Method of Inducing Labour.—This method of inducing labour is dependent on the stimulation of uterine action by drugs; it was introduced by Watson, and has recently come into prominence. Its great advantage is that there is no intra-uterine interference and no risk of infection; the method is therefore harmless. It is more likely to succeed in provoking the onset of labour at or after term than before term. It is therefore particularly suited to cases of prolonged or post-mature pregnancy, in which it may be deemed advisable to terminate pregnancy because the fœtus is becoming too large. There is no doubt that castor oil has a powerful stimulating effect on the uterine muscle, just as it has on the muscle of the intestinal tract; quinine also stimulates the uterine muscle, and it is interesting to note that quinidine, one of its derivatives, is given for its stimulating effect on the cardiac muscle in certain forms of myocardial disease. The action of pituitrin on the uterus has been described on p. 293. The following is a summary of the routine that may be employed:—

7 a.m.	Castor oil, one or one and a half ounces.
8 a.m.	Patient placed in a hot bath up to the waist for fifteen minutes; a light breakfast is taken after the bath.
9 a.m.	A large warm enema is given; after the enema has acted a tight abdominal binder is applied.
10 a.m.	Quinine sulphate, gr. x., in cachets.
12 noon.	Quinine sulphate, gr. v.
2 p.m.	Quinine sulphate, gr. v.
4 p.m.	Quinine sulphate, gr. v.

If pains have not begun, pituitrin, $\frac{1}{2}$ c.c., is given at 9 p.m. and is repeated at 10 p.m., but it is not advisable to give further doses. The patient may not be able to tolerate the last dose of quinine. If the method does not succeed the first time it may be repeated in two days. Success may be expected in

90 per cent. of mature or post-mature cases and in 70 per cent. of premature cases.

General Considerations.—Slow methods of induction are suitable for non-urgent indications, such as pelvic contraction, albuminuria and nephritis, chorea, heart disease, etc. Cases of ante-partum hæmorrhage, with the exception of the concealed accidental form, may also be dealt with by these methods. The simplest is the intra-uterine bougie method of Krause; the sole disadvantage attending it is the delay which often occurs in the establishment of effective uterine contractions. This delay may be greatly shortened by removing the bougies and introducing the smaller de Ribes's bag as soon as sufficient dilatation of the cervix to allow of this being easily done is produced; this usually occurs in twenty-four to forty-eight hours, even if labour is not actually excited.

De Ribes's bag is the best method to employ to provoke labour in cases of placenta prævia; if the cervix is insufficiently dilated the smaller size may first be used, in order to produce sufficient dilatation to allow of the introduction of the larger bag.

Digital Dilatation of the Cervix

When the cervix is sufficiently dilated to admit two fingers, full dilatation may be produced by digital stretching. The greatest attention must be paid to aseptic technique, sterilised rubber gloves being worn by the operator, and the vulva and vaginal canal being thoroughly cleansed and swabbed with tincture of iodine. The thumb and index finger of one hand are first inserted, and the cervix stretched as far as possible by separating them. Then the remaining fingers are successively introduced, until all the fingers of the hand can be passed through the internal os; this necessitates the passage of the entire hand into the vagina. Another method in which both hands are employed is also used: after two fingers of one hand have been passed the corresponding fingers of the other hand are introduced, and the cervix stretched by separating the fingers of the two hands.

This method requires an anæsthetic, careful aseptic precautions, and the exercise of gentleness and great patience in its performance; even then very serious lacerations of the vaginal vault or of the cervix running up into the lower segment, and even complete rupture of the uterine wall, may occur, for it is impossible to graduate the amount of force applied in this manner. It may consequently never be used as a method of inducing labour, but it may safely and conveniently be employed under anæsthesia to complete dilatation in cases of prolonged first stage when the cervix is already at least one-half dilated.

Vaginal Cæsarean Section.

This operation consists in deeply incising the cervix so as to allow of the immediate delivery of the fœtus through the natural passages. It is described on p. 661.

Accouchement forcé.

This procedure is defined by Munro Kerr as 'rapid and forcible enlargement of the cervical canal and immediate extraction of the fœtus.' It therefore includes the methods of forcible and rapid digital dilatation, dilatation with the branched dilators of Bossi, and rapid extraction of the fœtus by pulling on the leg after version. These are operations of great gravity, and are attended by risks of serious injury to the maternal passages and a correspondingly high maternal mortality. Further, they cannot be made use of when pelvic contraction is present, if it is desired also to save the life of the child. These methods are seldom, if ever, employed. Cases in which the immediate evacuation of the uterus becomes necessary owing to some urgent maternal complication are by preference dealt with by Cæsarean section. In comparison with the procedures classed under *Accouchement forcé*, Cæsarean section is simpler, safer, is equally expeditious, and is applicable to all conditions.

Dilatation by Branched Metal Dilators.—This method, introduced by Bossi in 1887, has been described in previous editions, but extended experience of its use has been so unfavourable that it is now regarded as too dangerous for general use. No description of it need therefore be given.

Version: Turning

Version consists in altering the presentation of the fœtus in the uterus; this may be done in order to correct an unfavourable presentation, or for other purposes which will be referred to below. As a rule the breech is made to present (*podalic version*); sometimes, however, it is the head (*cephalic version*). The conditions under which it may be desirable to change the presentation are various, and this is true also of the purposes which it is intended to effect.

(1) In transverse cases it is essential that the presentation should be changed; before labour, cephalic version is to be recommended; during labour, podalic version, followed by pulling down a leg.

(2) In breech presentations seen before labour or early in labour cephalic version should be performed; not only is a favourable presentation thereby substituted for an unfavourable, but the sizes of the fœtal head and maternal pelvis can be compared.

(3) In certain face, brow and persistent occipito-posterior

presentations, when the head will not enter the pelvis, and the pelvis is not contracted, podalic version is indicated.

(4) In placenta prævia podalic version is extensively employed as a means of immediately controlling hæmorrhage.

(5) In prolapse of the cord podalic version may be performed if the head is not engaged, to relieve the cord from the risk of compression by the head.

(6) In cases of moderately contracted flat pelvis 'prophylactic' podalic version was in the past often employed, as it was believed that passage of the after-coming head was easier in this kind of pelvis than that of the fore-coming head. This

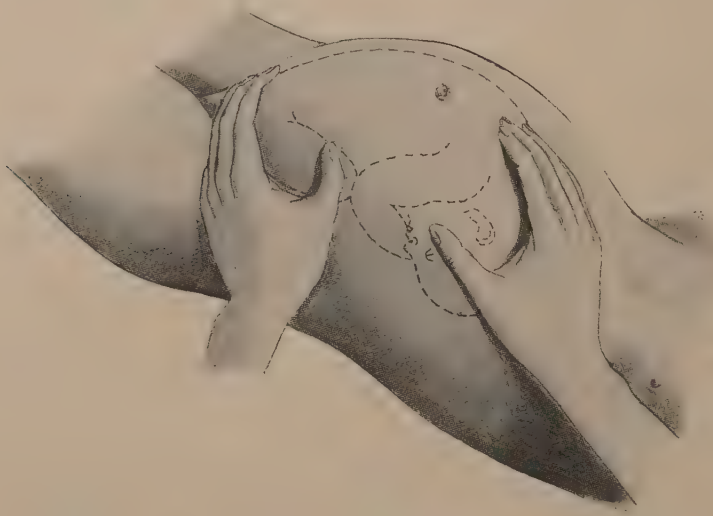


FIG. 335.—External Cephalic Version with the woman in the Trendelenburg position. (Galabin and Blacker.)

indication is nowadays seldom followed, because (*a*) Cæsarean section has become so very much safer; (*b*) it is realised that the gradual moulding of the fore-coming head is more favourable than the rapid passage of the after-coming head.

(7) When the cervix is three-quarters dilated and the pelvis of normal size and the head is not engaged, podalic version may be practised alternatively to the high forceps operation as a method of hastening delivery, when this is indicated by maternal complications or by fœtal distress. Under such circumstances version is probably safer than forceps, though both are risky.

Version may be performed by external (abdominal) manipulations alone, or by combined internal and external manipulations. When the operation is performed by external manipulations alone, it is termed *external version*; when performed by

one hand introduced into the uterus and the other hand on the abdomen, it is termed ' combined manual version ' or *internal version ;* when performed by one or more fingers introduced through the cervix and the other hand on the abdomen, it is termed ' combined digital version ' or *bipolar version.* It is important to realise that all three methods are strictly ' bipolar,' in that both poles of the fœtus are, or should be, acted on separately, the fœtus being subjected to the action of what is known in mechanics as a ' couple of forces.' In the following descrip-

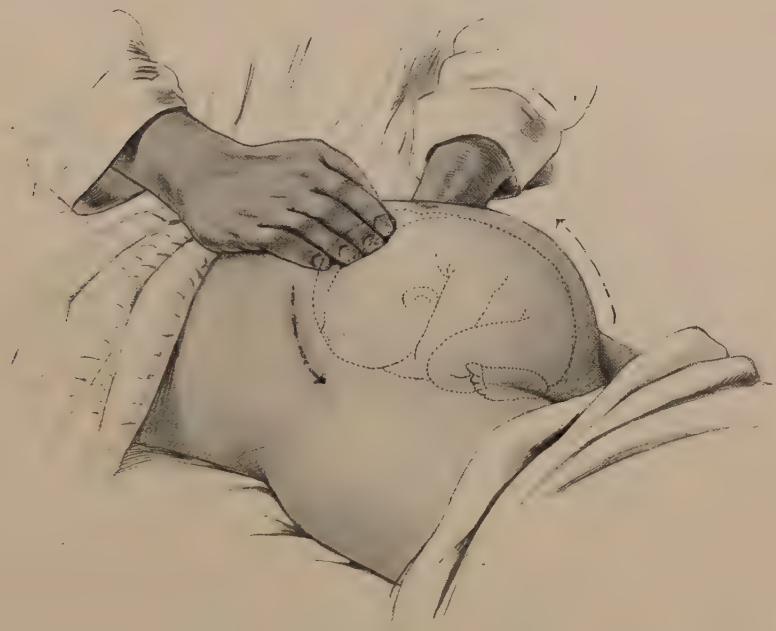


Fig. 336.—External Version in Breech Presentation. First Stage. The hands are locating the position of the head ; the head and breech are to be pushed aside in opposite directions, as shown by the arrows.

tion the customary nomenclature will be adhered to, and the two methods of combined version will be referred to respectively as *internal version* and *bipolar version.*

External Version.—The fœtus *in utero* can be turned by abdominal manipulation if there is a sufficiency of liquor amnii, if the uterus is not contracting frequently and powerfully, and if the abdominal walls are lax. The time for its performance is therefore before labour sets in, or very early in labour ; it is much easier in a multipara than in a primigravida. Full surgical anæsthesia is required if strong and frequent labour

pains are present. When any difficulty is experienced in disengaging the presenting part the Trendelenburg position will be found useful, or the part may be pushed up vaginally by an assistant. It is the method of choice in all cases of breech and transverse presentations seen before or early in labour. In both of these instances cephalic version should be performed —*i.e.*, the head should be made to present. External podalic

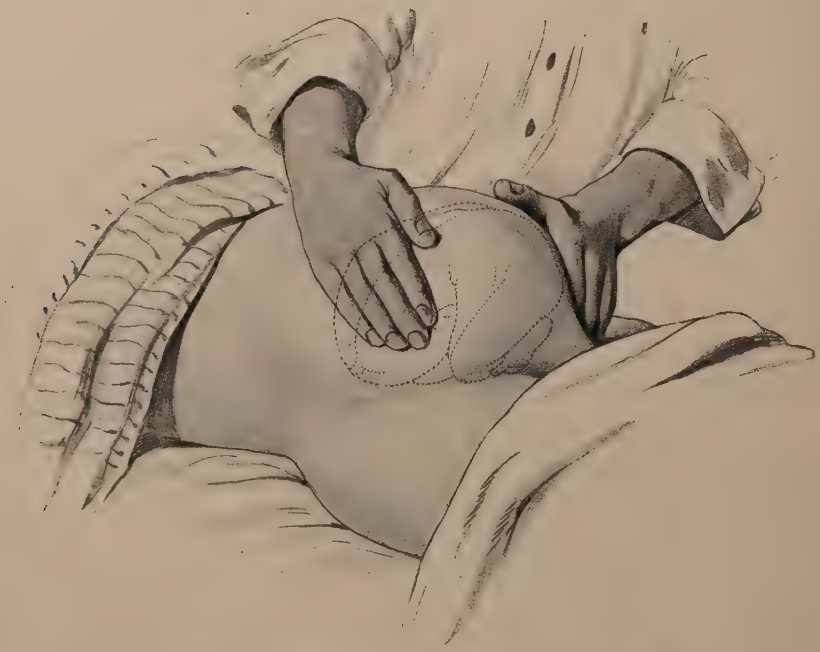


Fig. 337.—External Version. The presentation is transverse, the first stage having been completed.

version may be made use of in placenta prævia as a preliminary to pulling down a leg into the cervix.

In performing external version it is dangerous to use more than a moderate amount of force ; cases are known in which the placenta has become separated by forcible attempts, and injury of the broad ligaments and blood vessels is not beyond the range of possibility.

(*a*) *Breech Presentation.*—The patient should lie on her back with the shoulders slightly raised and the knees flexed, the abdomen being completely uncovered. The position of the head should first be located ; it will usually be found in a breech presentation distinctly to one side of the mid-line (Fig. 335). The breech will be found as a rule lying above the brim ; if

labour is in progress and the membranes have ruptured it may be engaged.

The *first stage* consists in applying pressure to the head and to the breech with the hand in opposite directions, so as to push the head down towards the pelvis and the breech upwards upon the opposite side of the uterus towards the fundus (Fig. 336). The effect of this movement is to make the presentation transverse. If the abdominal walls are lax, as in a multipara, and the patient is not in labour, this stage is very readily carried out ; in a primipara, if labour is in progress, considerable difficulty may be encountered, and it may be necessary to give an anæsthetic.

FIG. 338.—External Version. Second Stage. The lie of the fœtus has been made longitudinal, and the head is being adjusted over the pelvic brim, while the breech is being pushed into the mid-line at the fundus.

The *second stage* continues the movement begun in the first until the head has been brought over the pelvic brim and the breech pushed up to the fundus (Fig. 338). The head must now be carefully adjusted in the brim and the long axis of the fœtal trunk made to correspond with the long axis of the uterus. Unless this point receives careful attention, recurrence of the displacement will almost certainly take place.

The *third stage* consists first in pushing the head down into the brim as low as possible by grasping it with the two hands (Fig. 339). Finally, steady pressure is made upon the fundus so as to push the whole fœtal body as low down in the abdomen as possible. This has the effect of flexing the spine and the head, the object being to restore the normal attitude of general flexion

as nearly as possible, for this attitude may have been disturbed by the previous manipulations. To prevent recurrence of the displacement a thickly folded towel may be laid on each side of the uterus and a tight binder applied over all. The patient should be examined the next day to find out if the presentation has changed.

Attempts to correct a breech presentation by external version do not always succeed, even under an anæsthetic ; the operation is more difficult when the legs of the fœtus are extended.

(*b*) *Transverse Presentation.*—When a transverse presentation

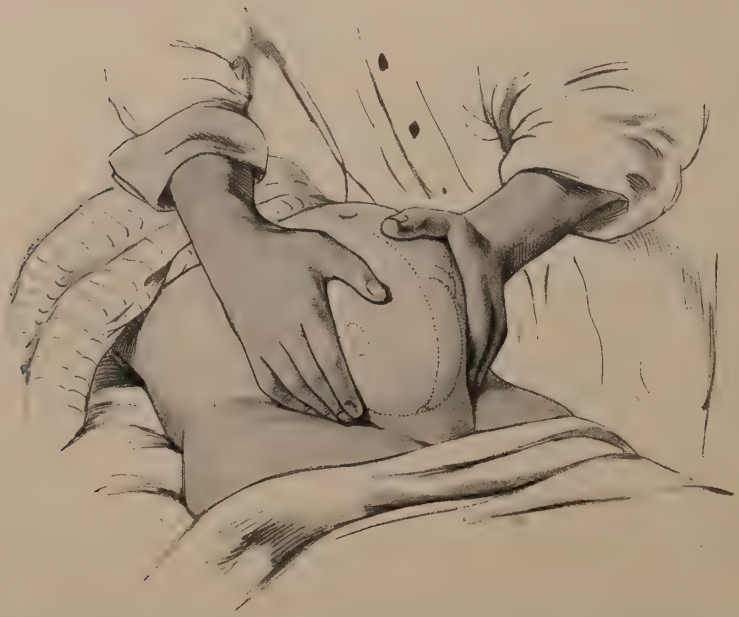


Fig. 339.—External Version. Third Stage. The head is being pushed down into the pelvic brim, a vertex presentation having been produced.

is met with, the possibility of the pelvis being contracted must always be borne in mind, and careful measurements must be taken. External cephalic version is performed, after which an examination is made to find out if there is any disproportion between the head and the pelvis. If the amount of disproportion is such as is likely to prevent natural or assisted delivery, Cæsarean section is the correct treatment. The version is naturally much easier of performance in transverse than in breech presentations.

Internal Version.—This operation consists in introducing the hand into the uterine cavity, seizing the feet and, with the

assistance of abdominal manipulation, turning the fœtus so as to bring down the pelvic extremity; under urgent conditions this may be followed by immediate extraction, but if the circumstances permit, time should be allowed for natural delivery to take place as in the management of a breech labour. Internal version is a very old obstetric procedure, and was

Fig. 340.—Effect of seizing the Lower Leg in turning a Transverse Presentation. The back is rotated to the front. (Farabœuf and Varnier.)

described and practised by Hippocrates; later writers upon obstetrics also have all described it (Celsus, Galen, Ambroise Paré, Baudelocque, Smellie), so that it has probably been in unbroken use for two thousand years. The earlier records of the operation show that it was then used to bring down the head (cephalic version); within recent times it has been employed only as a method of podalic version. This method of

version differs from the others in providing not only for changing the presentation, but also for immediately delivering the fœtus should the necessity arise. The operation is by no means devoid of risk, and should not be performed except under perfectly clear indications. It is absolutely contra-indicated by

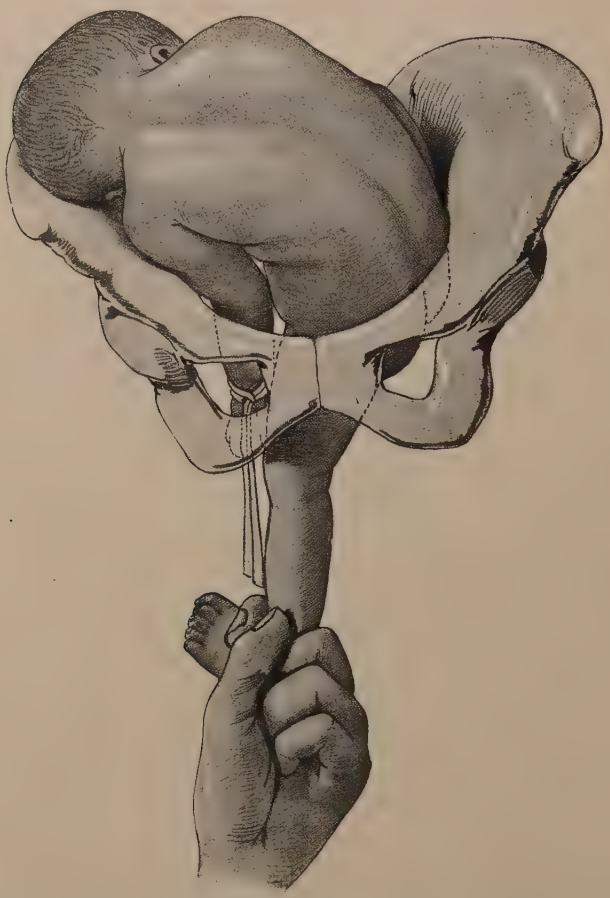


Fig. 341.—Effect of seizing the Lower Leg in turning a Transverse Presentation. (Farabœuf and Varnier.)

tonic uterine contraction ; and whenever some time has elapsed since rupture of the membranes it should not be attempted unless the mobility of the fœtus is good, and the hand can be introduced without force into the uterus. When the fœtus is dead, a destructive operation such as decapitation or craniotomy should always be preferred. Unless the conjugate diameter of

the pelvic brim measures at least $3\frac{1}{2}$ inches, version is an unsuitable method of delivering a living child in a flat pelvis, and in all degrees of generally contracted pelvis it should be avoided. The strictest antiseptic precautions are called for, and the manipulations must be carried out with gentleness and deliberation ; only in this way can the risks of sepsis and rupture of the uterus be reduced to a minimum. The operation can only be

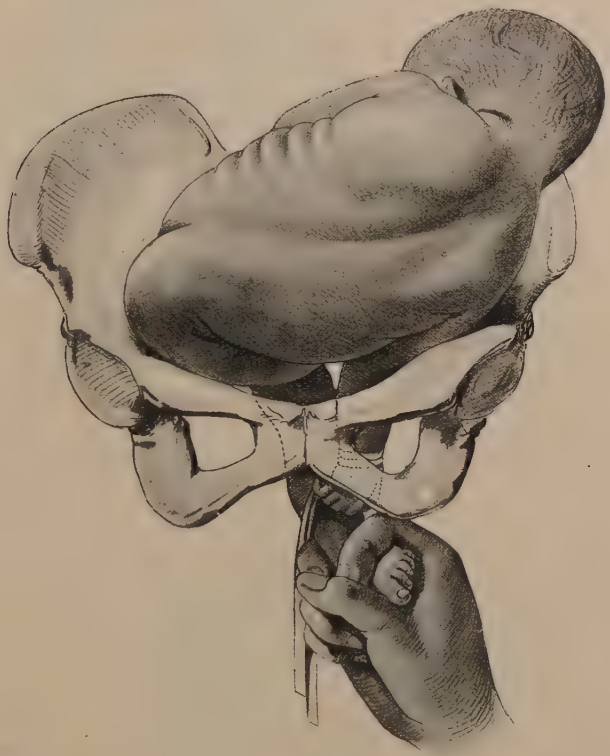


Fig. 342.—Effect of seizing the Upper Leg in turning a Transverse Presentation. The back is rotated posteriorly. (Farabœuf and Varnier.)

performed if the cervix is sufficiently dilated to admit the hand ; the most favourable moment for its performance is when the cervix is about three-fourths dilated and the membranes are unruptured.

The most important part of the procedure consists in seizing and pulling down a foot ; it is usually better to pull down one foot only and complete the extraction as a half-breech. In cases where rapidity is desired both feet may be pulled down at the

same time, or the second may be sought for after the first has been pulled down. Internal version is essentially a combined method of version ; if it is performed merely by pulling on the leg and without external manipulation of the fœtus, rupture of the uterus is much more liable to be caused in difficult cases.

The first point requiring attention is that the hand should

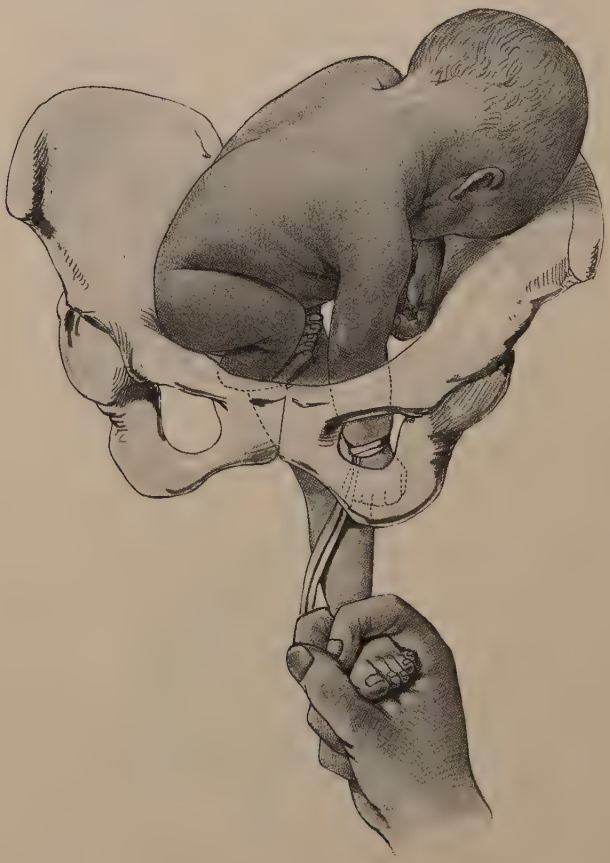


Fig. 343.—Effect of seizing the Upper Leg in turning a Transverse Presentation. (Farabœuf and Varnier.)

not be mistaken for the foot. The great mobility of the thumb is of course distinctive of the hand ; but it is not always easy to recognise this, when, for example, the limb can only be reached with the finger tips. As Munro Kerr has pointed out, the most distinctive part of the foot is the heel, which can be recognised by one finger, and serves absolutely to distinguish it from the hand. If this point cannot be made out, the fingers

should be passed up to the buttocks and drawn down the thigh and leg until the foot is reached.

The next point is the choice of a foot, which is important, inasmuch as, although either will do, extraction is greatly facilitated by selecting the proper foot. The principle govern-

Fig. 344.—Effect of seizing the Upper Leg in turning a Transverse Presentation. (Farabœuf and Varnier.)

ing the choice is that that foot should be seized which, when drawn down, will cause the back of the fœtus to rotate forwards; if the wrong one is seized the back will rotate backwards. The rule is that in transverse presentations, when the position is dorso-anterior, the lower foot should be pulled down, when dorso-posterior, the upper foot. From Figs. 340 to 344 it will be seen that the direction in which the trunk rotates is controlled

by the choice of a foot when one only is pulled down. As the delivery of a breech presentation is much easier when anterior rotation of the back occurs, it is important that the proper foot should be pulled down. In head presentations the choice of a foot is unimportant, as dorso-anterior positions necessarily become dorso-posterior after turning. In seeking the proper foot it must be recollected that in the normal fœtal attitude the legs are often crossed ; in a transverse presentation it accordingly follows that the foot first encountered is not necessarily that of the lower limb. In order to be sure the fingers must be

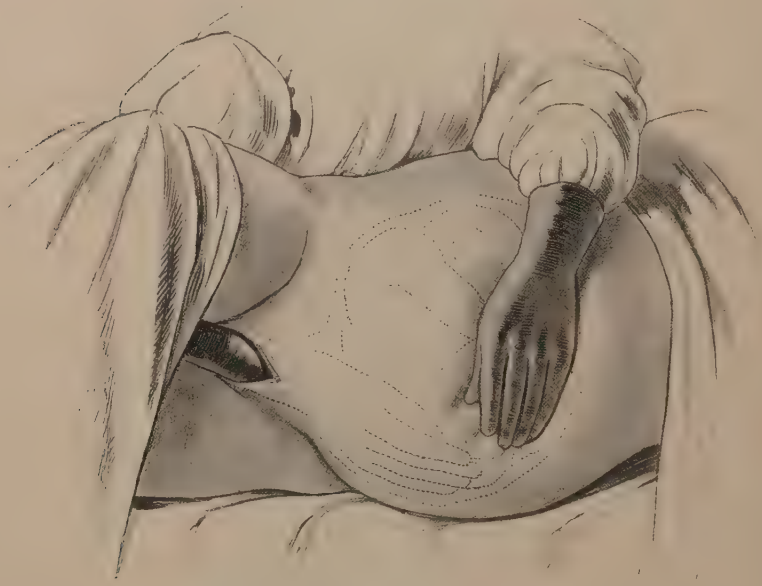


FIG. 345.—Internal Version for Transverse Presentation : introducing the Hand into the Uterus. Patient in left lateral position. (After Nagel.)

passed up to the buttocks and the desired foot found by following down the thigh.

Preliminaries.—An anæsthetic should always be administered, for should the patient move unexpectedly while the operator's hand is in the uterus, the risks of rupture are considerable. The bladder should be emptied by catheter. The position of the back and head of the fœtus should be carefully localised by abdominal and vaginal examination, and the fœtal heart auscultated. The approximate size of the pelvis and of the fœtus must also be estimated. The operation is best performed with the patient in the dorsal position. Potter has recently

pointed out that she should not be placed in the usual lithotomy position, in which there is considerable divergence of the vaginal and uterine axes, but that the legs should be separated widely and held by assistants at about the same level as the body (the ' modified Walcher position '). If assistance is not available the patient may be placed in the ordinary lateral posture. The operator, after carefully disinfecting his hands and forearms, should put on a pair of sterile rubber gloves ; the vulva

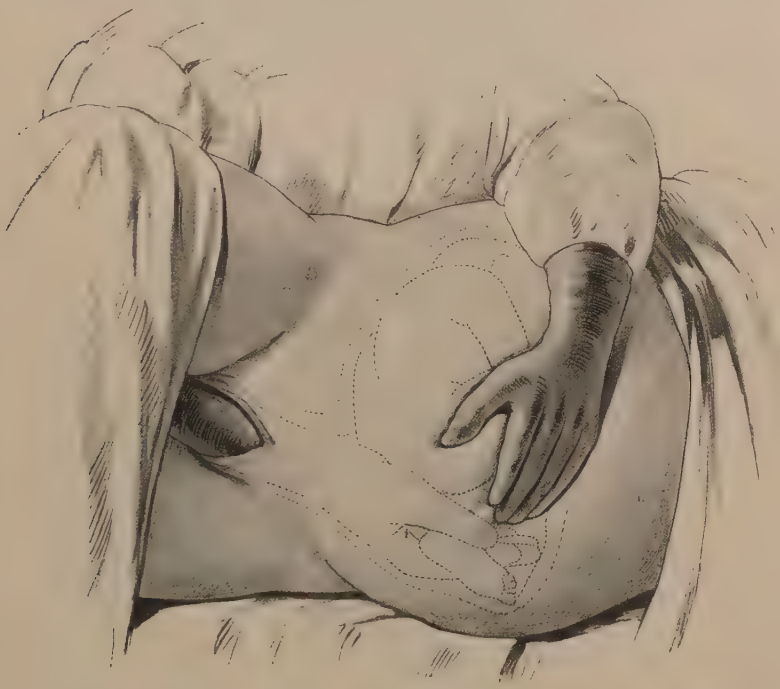


FIG. 346.—Internal Version for Transverse Presentation : seizing the Lower Foot. (After Nagel.)

should be shaved, and the vulva and vagina cleansed with soap, and then dried and swabbed freely with tincture of iodine.

Steps of the Operation.—(*a*) *When the presentation is transverse.* —When the head lies to the right, the operator uses his right hand for the internal manipulations, as this hand can be more easily directed to the left side of the uterus, where the feet are lying (Fig. 345). When the head lies to the left side, the operator uses his left hand.

(1) The hand should be passed into the vagina with the fingers and thumb bent into the shape of a cone (Fig. 290), and should not enter the uterus until the strong contractions and expulsive

efforts excited by its introduction into the vagina have passed away.

(2) In dorso-anterior positions the hand should follow the curve of the lower buttock and thigh until the *lower* foot can be

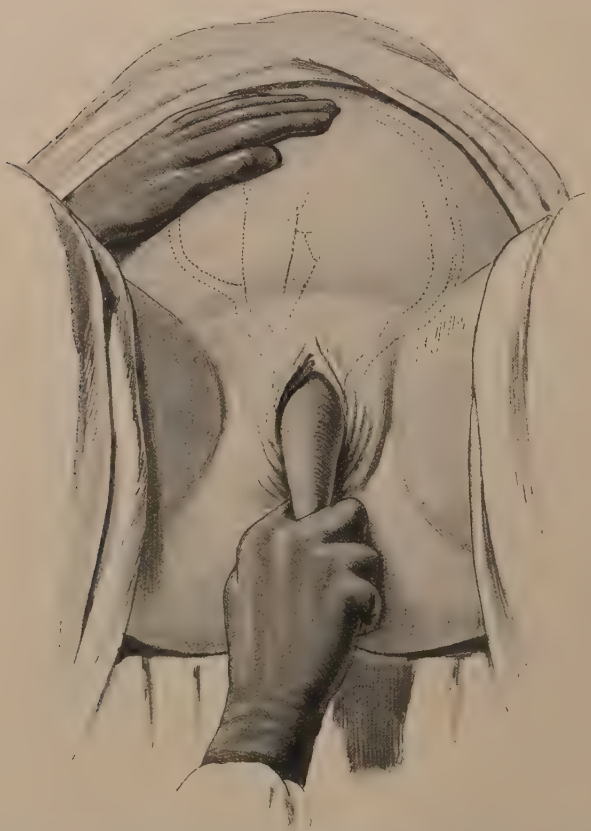


FIG. 347.—Internal Version: pulling the Leg down through the Vulva, and pushing the Head upwards with the other Hand. (After Nagel.)

reached, the external hand raising the pelvic pole of the fœtus so as to render it more accessible (Fig. 325).

(3) In dorso-posterior positions the hand should be passed over the ventral aspect of the fœtus, so as to reach the *upper* foot, aided by the external hand. The effect of seizing the upper foot will be to rotate the trunk so as to bring the back forwards and convert the presentation into an anterior breech.

(4) When the foot has been seized, it should be drawn gently down into the vagina, the head being at the same time pushed

up towards the fundus by the external hand or by an assistant Fig. 347).

(5) These manipulations should as far as possible be made during the intervals of the contractions, the internal hand making no advance during the pains, but being held flattened over the body of the child.

(6) The next step is the extraction of the fœtus. This must be done in the manner already described in the management of a breech labour. The risks of the arms becoming extended are great, for the attitude of the fœtus is necessarily disturbed

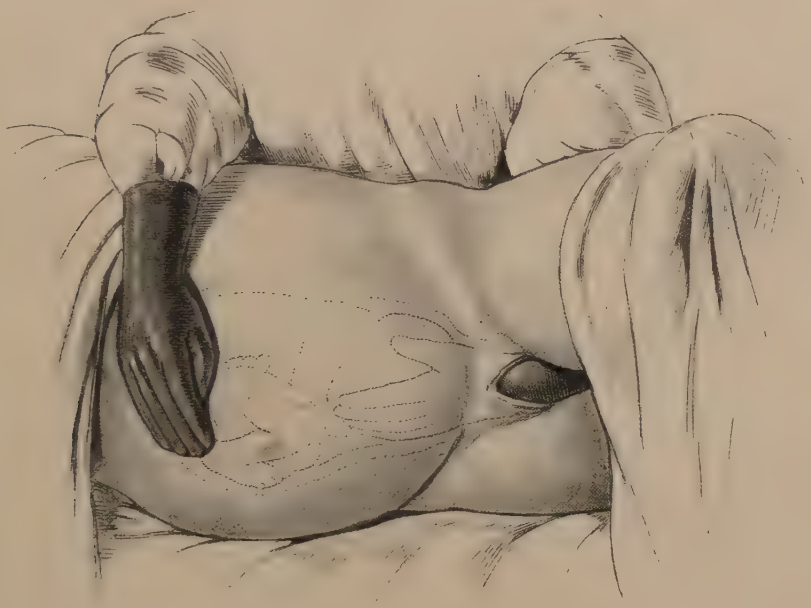


FIG. 348.—Internal Version for Vertex Presentation: introducing the Hand into the Uterus. Patient in right lateral position. (After Nagel.)

in turning. Sometimes in transverse presentations an arm may be found prolapsed before version has been commenced. A loop of gauze bandage should then be passed over the wrist, and sufficient traction made upon it to prevent this arm from being carried up into the uterus as the body is turned. If the other arm should become extended it will be brought down much more easily than if both were extended. Steady pressure on the fundus should be kept up by an assistant during extraction.

(7) After the delivery of the after-birth an antiseptic intra-uterine douche should always be given.

(8) Owing to the risks of fœtal asphyxia, preparations for the resuscitation of the infant should be made.

(*b*) *When the head presents.*—In non-engagement of the head in the pelvic brim, prolapse of the cord, in cases of ante-partum hæmorrhage, or in presentation of the face or brow, internal version of a head presentation during labour is sometimes called for. Whenever possible it is preferable to turn by the external method and then pull down the legs (p. 601). When the back lies to the right the operator uses his right hand; when the back lies to the left he uses his left hand. The steps of the operation are the same as in a transverse presentation, the hand being always passed along the ventral aspect of the fœtus; it does not matter in this case which foot is seized in turning. When the hand enters the uterus the head is necessarily pushed to one side, thus facilitating its displacement upwards by the external hand later on. It is more difficult to turn a head than a transverse presentation, as the long axis of the fœtus must be made to cross the transverse axis of the uterus. It follows that this method of delivery in head presentation must not be attempted unless the conditions are quite favourable, and sufficient liquor amnii remains in the uterus to allow free mobility of the presenting part.

Difficulties in performing Internal Version.—Under favourable conditions internal version is a simple and an easy operation; but the extraction of the fœtus after it has been turned may be complicated by the arms becoming extended. When the membranes have been ruptured for some time and the amount of liquor amnii remaining in the uterus is small, turning is both difficult and dangerous. It is sometimes difficult to decide whether, in a given case, it is safe to make the attempt or not. These difficulties are most often encountered in transverse presentations when the fœtus is still alive. The presence of a well-marked retraction ring always contra-indicates any attempt at version; when the natural intermittent character of the uterine contractions has been lost, or the uterus does not become properly relaxed during the intervals, the introduction of the hand, even under full anæsthesia, excites violent expulsive efforts which greatly impede the manipulations and increase the risks of rupture. Unless the operator has had some previous experience of turning, he should not make the attempt when the conditions are not in all respects favourable.

The *risks* which attend internal version are clearly defined. First, there is the risk of *sepsis;* even if the hand of the operator is protected by a sterilised rubber glove, the danger of carrying infective material from the vulva into the uterus remains. It is therefore important that special aseptic precautions should be taken. Douching alone is quite inadequate. Secondly, there is the risk of *rupture of the uterus:* in the cases of difficulty

just referred to, this risk is great; in favourable cases the risk is remote so long as the manipulations are made deliberately and gently.

Bi-polar Version (method of Braxton Hicks).—During the first stage of labour, when the cervix is sufficiently dilated to admit one or two fingers, and the membranes are unruptured, or if ruptured a large amount of liquor amnii remains, it is possible to turn with the aid of the fingers introduced into the cervix. The essential difference between internal version and this method is that, as in the latter the whole hand is not introduced into the uterus, it can be performed at an earlier stage of labour. Bi-polar version is only used to produce a breech presentation.

It is seldom necessary to adopt this difficult method of version. Under most circumstances when it could be made use of it will be found easier to turn by the external method, and having thus brought down the breech into the brim, to pass two fingers into the cervix, rupture the membranes and pull down a leg. When in cases of placenta prævia it is desired to turn, external podalic version followed by immediate pulling down of a leg is preferable to the method of Braxton Hicks, inasmuch as it reduces the internal manipulations to a minimum.

Fig. 349.—Bi-polar Version: First Step in Head Presentation. Placenta Prævia. (Braxton Hicks.)

Preliminaries.—These are the same as for internal version; an anæsthetic, though not essential, is of great assistance.

The older obstetricians were accustomed to perform it in both transverse and head presentations. As its chief interest is now historical, a brief outline of the procedure is all that the student will require.

When the head presents.—(1) The head is pushed upwards out of the brim, and then into the iliac fossa *on the side to which the back of the fœtus lies* (Fig. 329); at the same time the breech is displaced downwards and to the opposite side.

(2) The presentation has now become transverse or oblique, and the operation is completed in the manner just described.

Obstetric Forceps

The construction of the modern obstetric forceps will be best understood by tracing the various phases through which the instrument has passed in its evolution.

The earliest forceps to be publicly described was that of Palfyn, a surgeon of the city of Ghent, in 1720. It consisted of a pair of spoon-shaped blades with wooden handles; the blades were applied to the sides of the head, and the handles tied firmly together so that the instrument could be used for

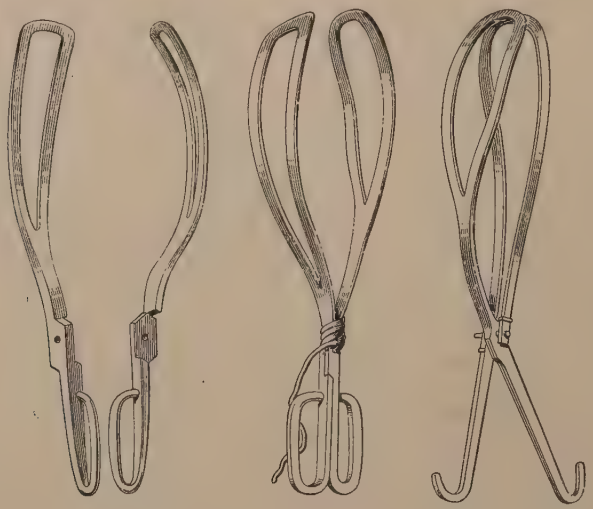


FIG. 350.—Different Patterns of Chamberlen's Forceps.

traction. Before this period (seventeenth century) an instrument had been used in London by a family of doctors, including at least three generations, named Chamberlen; the construction of their forceps was, however, maintained as a strict family secret, and not until long after the death of the last of their line did the secret leak out. In 1813 the three forceps represented in Fig. 350 were found by accident in an old chest in a house which one hundred years previously had belonged to the Chamberlens, and are believed to be the instruments with which they worked. These three forceps were distinctly better than Palfyn's; they consisted of a pair of metal, spoon-shaped, fenestrated blades, united like a pair of scissors with a pin-joint, and having curved scissors-handles; slight modifications in shape appear in the three forms, and in one a tape threaded

through and around the blades replaces the pin-joint. They are composed of three parts: (1) the curved blade, (2) the lock or joint, and (3) the handle; the curve, being designed to adapt the blades to the fœtal head, is known as the *fœtal*

FIG. 351.—Short or Straight Forceps.

or *cephalic curve*. This is the only curve upon these early instruments; viewed in profile, they are straight from end to end.

A forceps constructed upon this principle, and called the *short* or *straight forceps*, was used for some purposes until

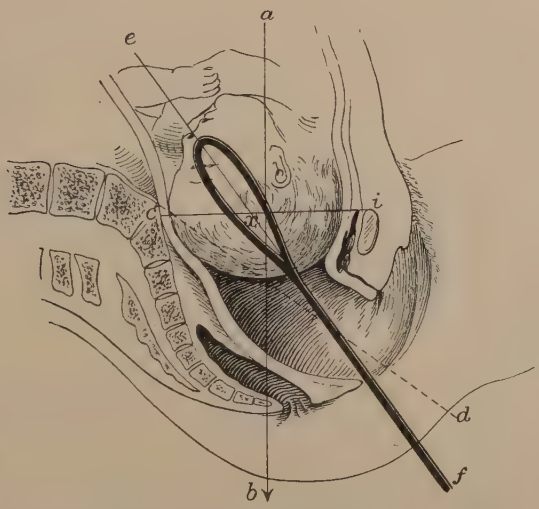


FIG. 352.—Straight Forceps applied to the Head at the Brim (Schematic). (Milne Murray.)

a, b. Axis of pelvic brim. *c, i.* Plane of pelvic brim. *c, d.* Axis of pelvic outlet. *e, x, f.* Direction of traction made by forceps.

comparatively recent years, but has now been generally abandoned (Fig. 351).

The faults of this forceps are easily demonstrated. The instrument is straight, but the pelvic canal, in which it has to lie, is curved; therefore, in grasping the fœtal head *at the brim*, a central grip cannot be obtained, for the instrument will

seize the part of the head which lies behind the centre (Fig. 352). In occipito-anterior positions, traction thus applied to the sincipital end of the head would induce extension. And further, in making traction, a great deal of the force will be

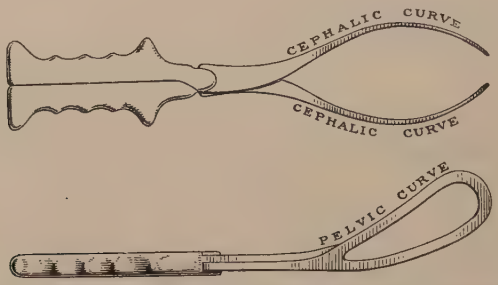


FIG. 353.— Obstetric Forceps, showing the Cephalic and Pelvic Curves. (Edgar.)

misapplied, for while the head must travel downwards and backwards in the line of the axis of the brim (Fig. 352, *a*, *b*), the direction of traction exerted by the forceps is in a line (*e*, *x*, *f*) intermediate between this and the axis of the outlet (*c*, *d*). A great deal of force will therefore be lost, and the soft parts crushed which lie between the head and the pubes. The misdirection of force is represented by the 'angle of error,' *b*, *x*, *f*. The application of this instrument to the head *in the pelvic cavity* is also open to objection, for it cannot be made to travel in any part of the pelvic axis without loss of much of the force applied.

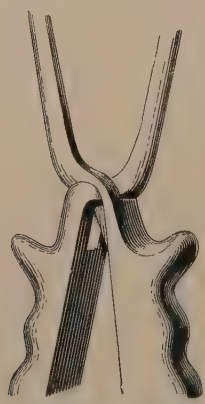


FIG. 354.—The Double Slot (English) Lock, and Shanks.

The first observer who attempted to remedy the faults of the straight forceps was Levret, of Paris (1751), who curved the blades forwards, so that they would lie accurately in the curve of the pelvic canal (Fig. 336); this second curve has become known as the *maternal* or *pelvic curve*. Minor modifications were made about the same period by a Scottish doctor practising in London named Smellie, who invented the double-slot lock, now used in all British forceps, and introduced between the blade and the lock a straight portion, $2\frac{1}{2}$ inches long, named the *shank*, which increased the length of the instrument so that the operator could lock it outside the vulva when applied to the head at the brim (Fig. 354). The result of these alterations

was thus to lengthen the forceps and add the pelvic curve. This instrument is now known as the *long* or *curved forceps.* As constructed at the present day it is made entirely of metal, so that it can be boiled. The total length of the instrument is 15

FIG. 355.—Long or Curved Obstetric Forceps.

inches ; the cephalic curve of the blade has a radius of $4\frac{1}{2}$ inches, and allows a maximum separation in the centre of $3\frac{3}{8}$ inches, with a minimum separation at the points of 1 inch ; the pelvic curve has a radius of 7 inches.

The great advantage of the pelvic curve is that it enables

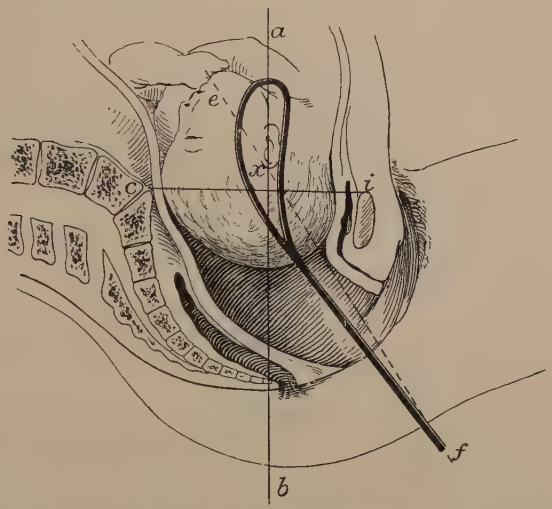


FIG. 356.—Long Forceps applied to the Head at the Brim. (Milne Murray.)

a, b. Axis of pelvic brim. *c, i.* Plane of pelvic brim. *e, x, f.* Direction of traction made by forceps.

the forceps to obtain a central grip of the head, which does not disturb its attitude ; but, as in the case of the straight forceps, there is great misdirection of the line of traction (compare Figs. 352 and 356). The direction of traction exerted by the instrument is represented by a line joining the handles with the centre of the fenestrum (Fig. 356, *e, x, f*). This line does not

pass through the centre of the pelvis at all, but lies entirely in front of it when the instrument is applied to the head at the brim ; its direction also diverges widely from the axis of the brim. The misdirection of force is represented by the angle *b*, *x*, *f*.

The long forceps received a further important modification at the hands of Tarnier, of Paris, in 1877. This observer first introduced the principle of *axis traction—i.e.*, he modified the instrument so that, at whatever level the head may lie, traction may be accurately applied to it in the *axis* of the pelvis, thus enabling all the force exerted to be employed in the most advantageous manner. This he did by adapting to the ordinary long forceps used in France a pair of curved metal rods by which traction could be made, known as the *axis-traction rods*. There are many points of difference between the French and English obstetric forceps which need not be described, but Tarnier's

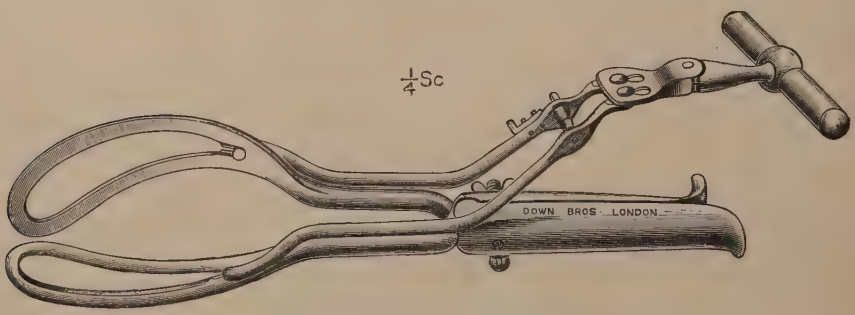


Fig. 357.—Milne Murray's Axis-traction Forceps.

invention was applied in 1880 to the English forceps by Sir Alexander Simpson. Simpson's instrument was further modified and improved by Milne Murray.

The axis-traction forceps of Milne Murray is shown in Fig. 357. The traction rods are attached by a slot at the base of the fenestrum on each side ; they are curved so as to lie in accurate contact with the lower ends of the blades and the shanks ; opposite the lock they are curved away from the handles, and connected together at their ends with an easily worked attachment. The ends of the traction rods lie about 3½ inches from the handles. To the ends when united is attached a transverse bar moving on a ball-and-socket joint, with which traction can be made. As the handles of the blades are only used in applying the instrument, and are not grasped when making traction, a screw is attached to them by which the grip of the blades upon the head can be retained. This is known as the 'fixation screw' ; it is not intended to produce compression of the head, but simply to retain the grip of the blades when traction is being

made. The handles themselves are made much lighter than in the ordinary long forceps, and may be conveniently distinguished as the 'application' handles, the transverse bar attached to the traction rods being called the 'traction' handle. The traction rods and handle are detachable, and the whole instrument can be sterilised by boiling.

When this forceps is applied to the head at the brim, traction made with the traction handle will cause the head to descend in the axis of the brim so long as the traction rods are kept in contact with the shanks (Fig. 358). The direction of the force applied is represented, in all positions of the instrument, by a straight line running from the point of application of the force

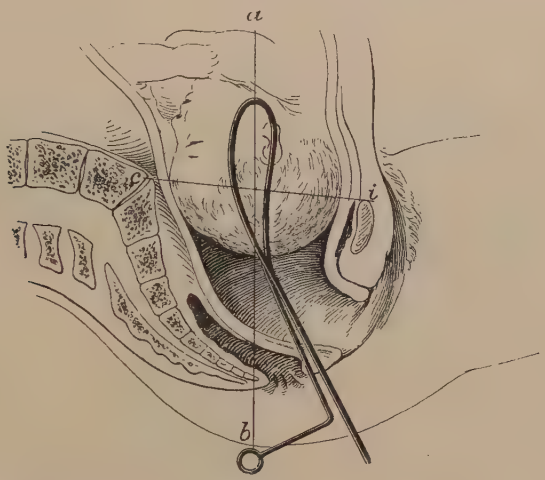


FIG. 358.—Axis-traction Forceps applied to the Head at the Brim. (Milne Murray.)

a, b. Axis of pelvic brim coinciding with line of traction.

(traction handle) through the centre of the fenestrum; when the head is at the brim, this line coincides exactly with the axis of the brim (Fig. 358); when the head is in the pelvic cavity, it coincides with the axis of the cavity at the level occupied by the head—*i.e.*, a line intermediate between the axis of the brim and the axis of the outlet. As long as the traction rods are kept in contact with the shanks the line of traction will always correspond with the axis of that part of the pelvis in which the head lies; and in pulling the head through the pelvis the application handles will be observed to incline more and more to the front as the head descends (see Figs. 366 and 367). It follows that none of the force applied is wasted, for the angle of error (*b, x, f*) seen in the case of the short forceps and the

ordinary long forceps has entirely disappeared (compare Figs. 352, 356, and 358).

Various attempts have been made to apply the principle of axis-traction in other ways. (1) It is maintained that axis-traction can be made with sufficient accuracy with the ordinary long forceps by the manœuvre of Pajot (Fig. 359). The right hand grasps the handles, making forward traction upon them ; the left grasps the shanks above the lock and makes backward traction upon that part of the instrument, forming a fulcrum between the two hands, upon which the blades will swing somewhat backwards when traction is being applied. It is clear that

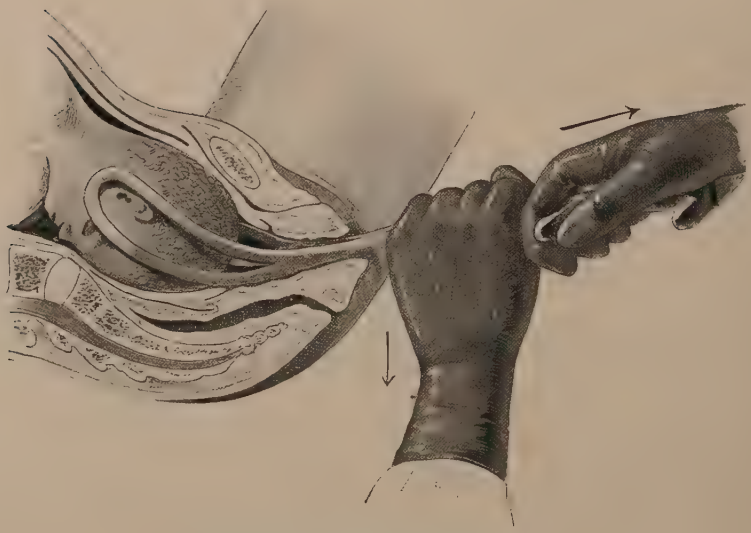


Fig. 359.—Pajot's Manœuvre.

it will be impossible to obtain even approximate accuracy of direction in this manner. (2) The second method is that of Neville (Fig. 360). Neville's forceps differs from Milne Murray's in having but a single traction rod, which is attached to the forceps just below the lock by a butterfly joint. The traction bar is differently jointed, but, like Milne Murray's, will move in all directions. The advantage possessed by this instrument is that it is easier to apply than Milne Murray's, but the direction of traction is probably not so accurate.

Modes of Action of Obstetric Forceps.—The action of the obstetric forceps is essentially that of making *traction ;* the blades also compress the head, but the amount of *compression* should be only so much as is required to ensure a firm grasp.

When properly applied the possible degree of compression is small, and is strictly limited by the cephalic curve of the instrument. If the head is gripped transversely, the bi-parietal diameter cannot be reduced below $3\frac{3}{8}$ inches. It is probable that prolonged compression of the head even to this extent may cause a certain amount of intracranial injury, for in such cases the fœtus is often born in a condition of white asphyxia. But injury to the cranial bones cannot be produced by this grip if the pelvis is normal. As we shall see, the usual grip obtained is transverse, or slightly oblique from before backwards.

It is when the instrument is so misapplied as to take an antero-posterior grip of the head that there is the greatest risk of injury. Reduction of size in this plane is followed by a compensatory increase in the vertical diameter—*i.e.*, the distance between the

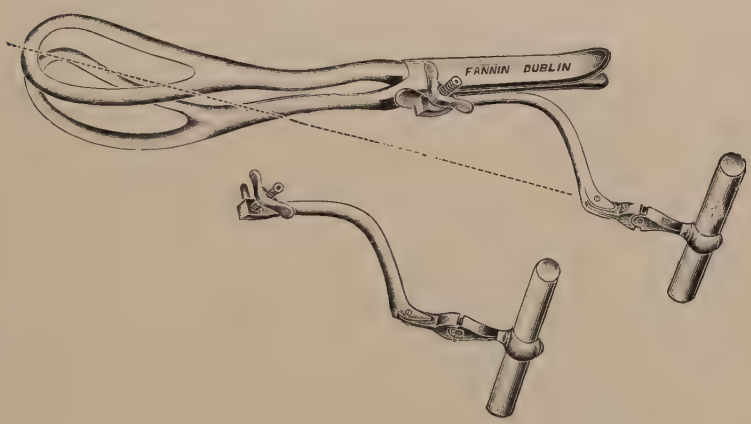


Fig. 360.—Neville's Axis-traction Forceps.

vertex and the base is increased. The transverse (bi-parietal) diameter is not much affected.

In occipito-posterior positions the forceps is sometimes used forcibly to *rotate* the head so as to bring the occiput forwards. This cannot be done, however, without risk of injury to the soft parts.

A *lateral lever action* may be exerted during traction by carrying the handles gently from side to side ; this sometimes aids extraction in a difficult case, but is very liable to damage the maternal tissues.

It is also clear that, when the head is in the grasp of the forceps, the lower parts of the blades will exercise a *dilating action* upon the vulva immediately in advance of the head (Fig. 367). And, lastly, the mere introduction of the blades often exerts a powerful *excitant action* upon the uterine contractions.

The variety of obstetric forceps which will be found most generally useful is the axis-traction forceps ; and Milne Murray's pattern is to be preferred on account of its greater accuracy. To operators who have become accustomed to the ordinary long forceps the axis-traction forceps appears clumsy and its application difficult ; but students can learn to apply it quite as easily as the long forceps. It is a great advantage to carry one kind of forceps only, and this is the only kind which is sufficient for all the requirements, whether of an easy or a difficult case. It is advantageous also to use the same form of instrument in all forceps operations, so as to become thoroughly familiar with its use ; and while it may be admitted that a *low* forceps operation can be easily performed with the ordinary long instrument, this certainly is not the case with a *high* operation ; here the axis-traction instrument is far more effective. The same must be said of pelvic contraction and all other conditions in which a considerable amount of force is required in traction ; the axis-traction pattern is far more effective. Because all the force applied through the instrument is effective, and none is lost, obviously the amount of force required is reduced to the minimum. When the head is low in the pelvic cavity the blades can be used without the traction rods, like an ordinary pair of long forceps.

It must also be borne in mind that this forceps does not interfere with the normal movement of rotation made by the head in passing through the pelvis, for the ball-and-socket joint on the traction handle allows the instrument and the head to rotate together. With the ordinary forceps, owing to the firm grip of the handles which is required, spontaneous rotation cannot occur, although of course forcible rotation can be performed by the operator.

It has been urged that excessive and continuous compression of the head is caused by the screwing together of the handles of the axis-traction forceps ; this is not the case, for, as we shall see, continuous compression implies improper use of the instrument ; the degree of compression required is only that necessary to ensure a firm grip of the head, and this can be regulated with far more accuracy by the screw than when the handles are firmly gripped in the act of making traction. The only valid objection to the instrument is its greater complexity and the corresponding greater difficulty in manipulating it ; this can be readily overcome by practice.

Indications for the Use of Forceps.—A few important general principles relating to the use of forceps may be first considered.

The obstetric forceps is an instrument designed for application to the head in presentations of the vertex or face, and to the after-coming head in breech labour. It is not adapted for direct application to the breech in breech labours, for the fœtal

abdomen is severely nipped between the tips of the blades, and injury to the abdominal viscera, especially to the liver, may occur ; other methods of delivering a difficult breech presentation can always be employed with success.

The forceps is not meant for overcoming considerable obstruction to the passage of the head through the pelvis by the application of powerful force ; if used thus, the soft structures of the genital canal (the cervix and vagina, and their immediate surroundings) and the fœtal head will both be severely damaged. The passage of the head through the pelvis may be hindered by its malposition as well as by disparity in size ; the forceps is only suitable if the head is well flexed or well extended ; brow, imperfectly extended face and imperfectly flexed occipito-posterior presentations must all be corrected before forceps is applied.

When the head has passed through the pelvic brim and lies with its greatest circumference in the pelvic cavity, the operation is usually simple and easy ; the lower the head has descended before the forceps is applied, the easier will be the extraction. When the head lies entirely above the pelvic brim, freely movable, unengaged and unmoulded, the operation is very difficult and dangerous, both to mother and fœtus. Unless the greatest diameter of the head is engaged the use of the forceps is contraindicated ; to this rule there are very few exceptions indeed. In cases in which, although the head is fixed in the brim and partly moulded, the greatest circumference has yet failed to pass through the pelvic inlet, resort to forceps should be delayed as long as possible, due watch being kept on the condition of the fœtal heart and the general condition of the mother. In any case, when the forceps is applied in cases of disproportion, the instrument should only be used tentatively and not with the object of terminating the labour with its help at all costs. The importance of allowing full time for moulding when the pelvis is contracted has been already insisted upon. When it is clear that extraction with forceps will be difficult, craniotomy should always be performed if the fœtus is dead.

The actual *indications* for the use of forceps in head presentations may be arranged into three groups :

(1) Abnormal prolongation of the second stage.
(2) Maternal complications.
(3) Fœtal dangers, indicated by signs of distress or prolapse of the cord.

(1) *Prolongation of the second stage.*—Forceps should not be applied merely to save the time of the medical attendant, or to shorten the duration of the second stage when labour is proceeding naturally. The length of the second stage is variable, and for practical purposes the strength of the pains must be taken into consideration, as well as the actual time which has elapsed.

When the pains are feeble and irregular much more time must be allowed than when they are strong and regular. When the head is detained in the upper part of the pelvis the use of forceps should be withheld as long as possible. When it has reached the pelvic floor and presents at the vulva there is not the same reason for delay.

The length of the second stage must be judged as much by its effects on the mother and fœtus as by its actual duration. On the mother the effect of undue prolongation is exhaustion, shown chiefly by a progressive rise in pulse rate ; on the fœtus the effect is revealed by the signs of fœtal distress (p. 570). It is better to anticipate these effects than await them. In the absence of disproportion, therefore, it is a good rule of practice to apply forceps after second stage pains have lasted for two or three hours and there appears to be no immediate prospect of spontaneous delivery ; if the head has reached the perineum, and there is no further progress after one hour, forceps should be applied without waiting longer.

These points being borne in mind, the following conditions may be enumerated as causes of abnormal prolongation of the second stage :

(*a*) Uterine inertia—primary or secondary.
(*b*) Rigidity of the vaginal outlet and perineum.
(*c*) Occipito-posterior positions.
(*d*) Pelvic contraction.
(*e*) Abnormally large size of the head.
(*f*) Mento-posterior positions of the face, brow presentations.
(*g*) Abnormal uterine obliquity.

The administration of chloroform and of sedative drugs both tend to prolong the second stage of labour.

In every case an attempt should be made, before applying forceps, to arrive at a conclusion as to the cause of the delay. It will be found that the three first-named conditions account for something like 90 per cent. of the cases in which the forceps is used. When the head is delayed on the pelvic floor the usual cause is to be found in ineffective contractions, or an unyielding perineum ; in rare instances contraction of the pelvic outlet may be present, as in a funnel pelvis. When the head is detained in the upper part of the pelvic cavity, and the uterus is contracting well, the commonest causes are an occipito-posterior position or some disproportion between the size of the head and that of the pelvis. In disproportion an abnormally large caput will form, and the head will become fixed ; in a posterior position the caput is not abnormally large, and the head usually remains movable. Therefore, when the delayed head shows a large caput, attention must always be directed to the size of the pelvis.

(2) *Maternal complications.*—In such conditions as heart disease it is obvious that prolongation of the muscular strain which accompanies the second stage must be detrimental to the mother, and accordingly forceps should be employed early in this stage. In eclampsia all obstetricians agree that as soon as the cervix is fully dilated extraction with forceps is indicated ; as in the majority of cases labour is premature and the fœtus small, extraction is not often difficult, even in a primipara. Occasionally in cases of premature rupture of the membranes signs of severe obstetric exhaustion may appear when the cervix is perhaps not more than half dilated, and to these may be added signs of fœtal distress. Under such circumstances prompt delivery by forceps must be practised, the dilatation having been previously completed by the digital method, or with the additional aid of incisions in the cervix.

(3) *Fœtal complications.*—The early use of forceps may be indicated by signs that the fœtus is suffering from the effects of labour, such as slowing of the rate of the heart sounds or the passage of meconium. This is especially likely to occur with a premature fœtus or with premature rupture of the membranes. Prolapse of the cord may also call for the early use of forceps. When the fœtus is dead, forceps delivery is suitable as long as the pelvis is of normal size and the head is not abnormally large. But in such cases, should extraction prove to be difficult, the forceps should be at once abandoned in favour of craniotomy.

Forceps in Pelvic Contraction.—It has been already mentioned in connection with the management of labour in pelvic contraction (p. 385) that, unless the conjugate measures at least $3\frac{1}{2}$ inches, a full-time fœtus of average size cannot be extracted by forceps without great risk of seriously injuring it. Consequently it is better not to undertake forceps delivery in a pelvis smaller than $3\frac{1}{2}$ inches. If a case is first seen at an advanced period of labour, when the head is firmly engaged in the brim, accurate measurement of the pelvis is impossible. We must then be guided by the amount of compression of the head which has taken place, as indicated by overlapping of bones and by the size of the caput. A prolonged second stage is requisite for a successful result. It has been already explained that an unmoulded head is much more difficult to deliver than one in which moulding has occurred ; but if the widest part of the head, though moulded, remains above the pelvic brim, the use of forceps is attended by great risks to mother and fœtus, and the prospects of delivery are very remote.

In all cases of pelvic contraction attempts to deliver with forceps must be made carefully, and should not be persisted in if no progress is being made after two or three steady pulls.

The shape of the pelvis is not of much importance from the

point of view of the forceps operation ; in both flat and generally contracted pelves it may be used with equal success in suitable cases. After failure to deliver with forceps it is, as a rule, unwise to attempt version ; if the head is firmly engaged in the brim and there is little liquor amnii present, version should never be performed, owing to the risk of rupturing the uterus ; if, however, these conditions are not present, version may be performed if the pelvis is flat, but never if it is generally contracted. In all varieties of contracted pelvis, axis-traction

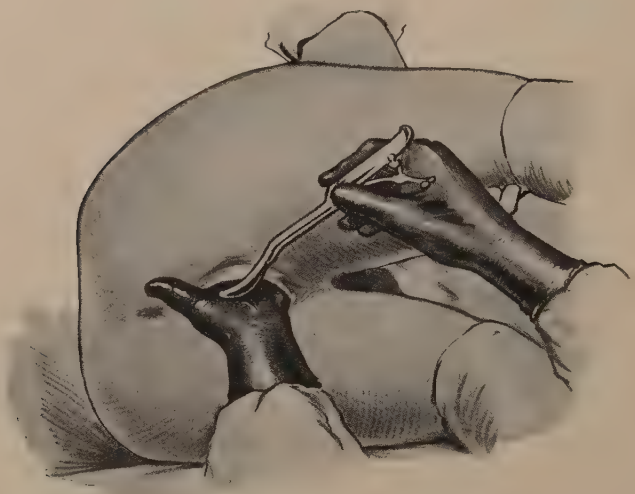


Fig. 361.—Application of Axis-traction Forceps. Introducing the left blade.

forceps are much more successful than the ordinary long forceps.

Application and Use of Forceps.—*Varieties of Forceps Operations.*—According to the degree of descent of the head into the pelvis when forceps is applied, it is customary to speak of three varieties of forceps operation : *low forceps*, *mid forceps* and *high forceps*.

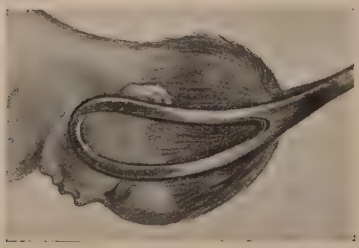
The *low forceps* operation is when the greatest circumference of the head has passed below the ischial spine plane ; the head then occupies the lower part of the vagina and rests on the perineum, and the delay in advance is due either to weak pains or to a rigid vaginal outlet and perineum. The low forceps operation is simple and easy and may be undertaken for slight indications.

The *mid forceps* operation is when the greatest circumference of the head has passed the pelvic brim but still lies above the level of the ischial spine plane ; the head occupies the pelvic cavity and the delay in advance is commonly due either to pelvic contraction (general contraction or funnel pelvis) or to a malposition such as occipito-posterior presentation with deficient flexion. The mid forceps is a more difficult operation than the low.

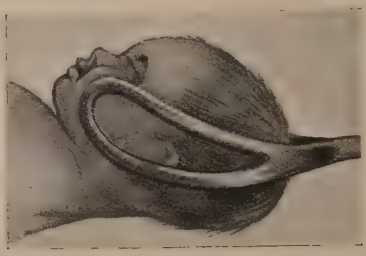
The *high forceps* operation is when the greatest circumference of the head has not passed through the pelvic brim. The high forceps operation is always difficult and dangerous, and is seldom indicated. Failure of the head to enter the brim is usually due to considerable disproportion ; if the head is partially moulded and is fixed in the brim the operation may be undertaken tentatively, but if the head is *floating* freely above the brim, the operation is absolutely contraindicated in cases of disproportion.

The Relation of the Forceps Blades to the Fœtal Head.—The forceps should be applied so that the blades lie directly along the sides of the head ; the long axis of the blades will then correspond more or less to the occipito-mental diameter, and the biparietal diameter will occupy the widest interval between the blades (Fig. 362, 1, 2, and 3). This is known as the *cephalic* as opposed to the *pelvic* application of the forceps. By the cephalic application a secure and safe grip is obtained and injurious pressure to the head is reduced to a minimum. By the *pelvic application* is meant that the forceps is applied directly to the sides of the pelvis, irrespective of the position occupied by the head ; if the head is lying transversely one blade will then lie over the forehead, and the other over the occiput, and if it is lying obliquely, one blade will lie over the mastoid and the other over the malar regions (Fig. 362, 4 and 5). Not only is an insecure grip obtained when the forceps is applied in this manner, but injurious pressure on the head is likely to be exerted. When the sagittal suture is directed antero-posteriorly, as is usually the case when the head is on the perineum, the pelvic and cephalic applications of the forceps naturally correspond, and this is the only condition in which the pelvic application is suitable. The pelvic application is naturally the easier of the two, because all that need be done is to slip in each blade in turn along the sides of the pelvis, the right blade along the left side and the left blade along the right side. The cephalic application is more troublesome, because the exact position of the head must be determined before the blades are applied. When the head is low down, its position is easily determined by passing two fingers into the vagina and noting the direction of the sagittal suture ; but when the head is at a higher level, it is often necessary to pass the hand into

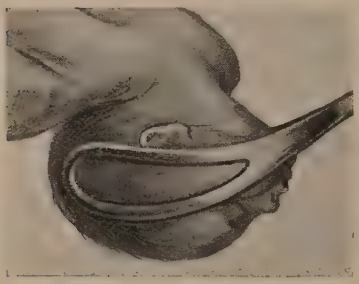
the vagina and locate the posterior ear. This should be done when the patient is anæsthetised and just before the application



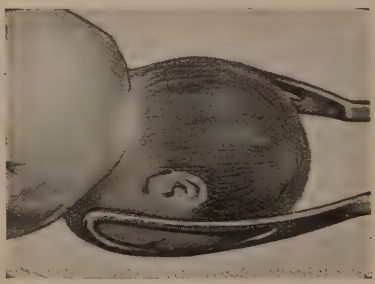
1. Forceps correctly applied to sides of head: occipito-anterior presentation.



2. Forceps correctly applied to sides of head: occipito-posterior presentation.



3. Forceps correctly applied to sides of head: face presentation.



4. Forceps incorrectly applied; obliquely to head.

5. Forceps incorrectly applied; antero-posteriorly to head.

FIG. 362.—Relation of Blades to Head. (After Whitridge Williams.)

of the forceps. After the ear has been located the hand is kept in position and the first blade, whether it be right or left, is applied over the ear; with the first blade correctly placed

the application and adjustment of the second is a simple matter.

Preliminaries.—Careful aseptic preparation of the hands of the operator and the vulva of the patient is of course necessary. The use of sterilised rubber gloves by the operator is advised in all cases. Shaving and disinfecting the vulva is as valuable a preventive of infection as the use of gloves by the operator, and should be done when the patient is anæsthetised. If sterilised gloves become soiled in passing through the vulva the chief advantage of using them is lost. The previously boiled forceps should be immersed in lysol solution (℥j to Oj) or

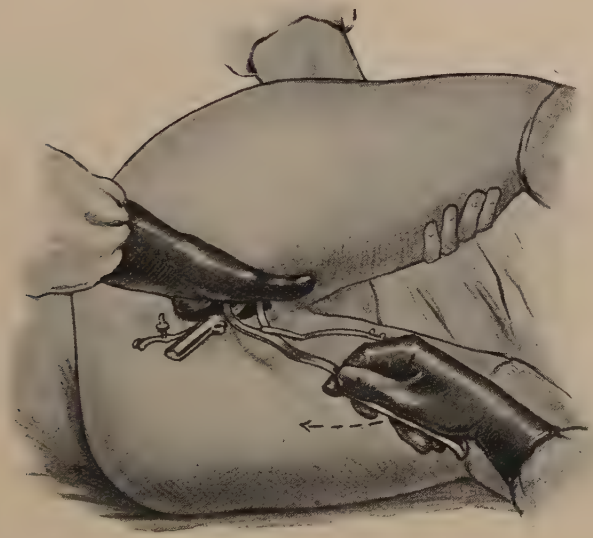


Fig. 363.—Application of Axis-traction Forceps. The left blade is in position, the handle only being seen; the right blade is being introduced.

carbolic (1 in 40) until required for application. The cervix must be fully dilated and the membranes ruptured. Uterine contractions must be present. The bladder must always be emptied by catheter, and an anæsthetic is desirable in all cases. The left lateral posture, the patient lying across the bed, is usually employed in this country, but the dorsal posture, with the legs flexed and the buttocks drawn to the edge of the bed (Fig. 371), is of great assistance in cases of difficulty, and the operator should become familiar with it; the former has the advantage of requiring fewer assistants. When the lateral posture is used the buttocks are drawn over the edge of the bed, and the right leg must be supported throughout the operation

by an assistant in the position shown in Fig. 363. The buttocks and thighs must be covered by sterile towels. A detailed examination of the presenting head should first be made, and for this purpose it is necessary to pass the ' half-hand ' into the vagina. This will enable the operator in cases of difficulty to locate the ears, which are useful in the diagnosis of position when the sutures and fontanelles are obscured by a large caput. The curve of the helix always corresponds with the occipital end of the head. Posterior positions should, if possible, be corrected by manual rotation, but if this cannot be satisfactorily

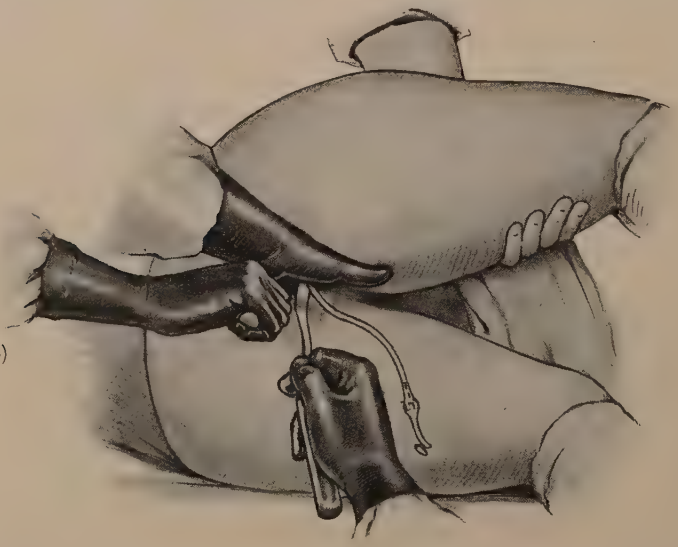


FIG. 364.—Application of Axis-traction Forceps. Further stage in introduction of the right blade.

(a) Assistant's hand holding the left blade.

accomplished the head will often be found to rotate during delivery when the axis-traction instrument is used, the blades being free to rotate while traction is being made. If the membranes remain unbroken they should of course be ruptured artificially.

Application of the Axis-traction Forceps.—(a) When the head is in the lower part of the pelvic cavity. ' Low ' Forceps Operation.—In a simple case the blades are applied in the transverse diameter of the pelvic cavity. If internal rotation is complete the head will be gripped in its bi-parietal diameter ; if the movement of internal rotation is incomplete, the blades must be adjusted accordingly.

The left half is usually applied first ; this will be the lower half in the left lateral posture. The handle is held lightly in the right hand, the traction rod being kept in close contact with the shank. The fingers of the left hand are passed into the vulva and carried up into contact with the cervix on the left side of the head. The blade is then passed along the palmar surface of the fingers in the antero-posterior diameter of the vulva, and directed at first backwards towards the sacral hollow, the instrument being held in a nearly vertical position as shown in Fig. 361. The handle is then carried backwards in a wide sweep, and the blade at the same time

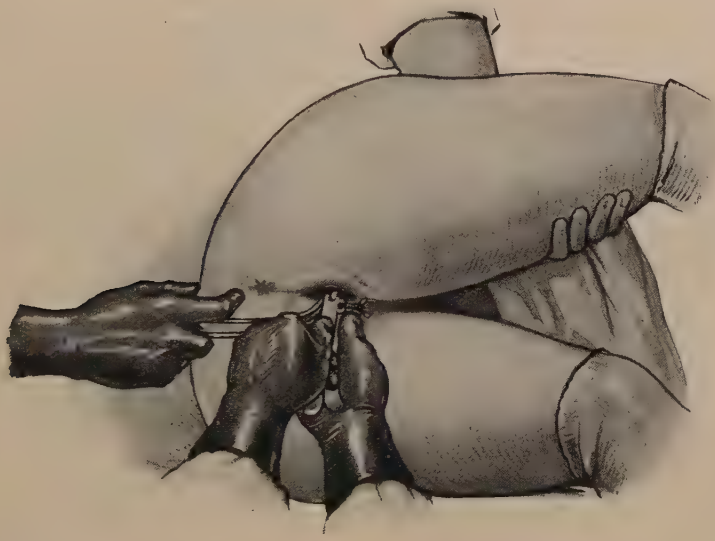


Fig. 365.—Application of Axis-traction Forceps. Locking the blades ; the traction rods are held aside by an assistant.

directed by the internal fingers to the left (of the mother) until it lies in the transverse pelvic diameter ; the blade must be kept in contact with the scalp, the lip of the external os being protected by the fingers. This movement sweeps the blade round the left (maternal) side of the head. Without exerting any force, the blade will be found to pass deeply into the pelvis until the shank comes to lie upon the perineum (Fig. 363). The traction rod now lies behind the applied blade. The left blade may be held in position by an assistant as shown in Fig. 364 ; unless held while the other blade is being introduced, it is not easy to retain it in the position in which it has been placed. The right half of the forceps is next taken in the

right hand ; the left hand is pronated, and the fingers used as before to guide it into the vulva. The blade is first directed towards the sacral hollow, and then, the handle being held parallel to the left thigh, the blade is directed by the fingers round the right side of the pelvis into the transverse diameter, the same precautions being taken as in introducing the left half. It is necessary to *depress* the handle of the right half in order to carry the blade upwards to the right side of the pelvis (Fig. 364). The movement is completed by carrying the handle backwards, as the blade passes deeply into the pelvis. Both traction rods

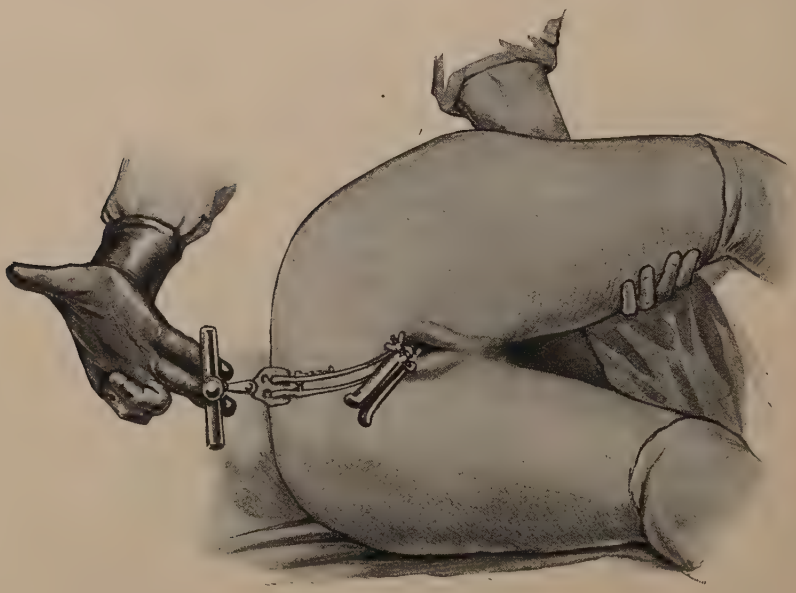


FIG. 366.—Showing the Position of the Traction Rods and Handles after the Instrument has been applied.

should now lie behind the shanks, and the instrument is locked by taking a handle in each hand and carefully adjusting the slots (Fig. 365). It is convenient to have the traction rods held back by an assistant when locking the forceps ; but this is not required after a little practice. If the instrument has been accurately applied the shanks will lie in such a position that locking is easy ; sometimes, however, the blades lie so that they cannot be locked without forcibly rotating one or both of them in order to adjust the slots to each other. If the blades have been carefully applied in the transverse diameter of the pelvis, difficulty in locking signifies that rotation of the head has not occurred, and the blades should be removed and

reapplied in an oblique diameter of the pelvis (*vide infra*). Serious injury to the head may result from forcibly locking badly adjusted blades. After locking, the application handles are screwed lightly together with the fixation screw. They lie against the perineum, and it will be noticed that they are directed downwards in the axis of the pelvic cavity (Fig. 366). Next the traction rods are connected, and the traction handle applied. A careful examination should be made before traction is begun, to make sure that nothing but the head has been included in the grip of the instrument.

Difficulty in the application and adjustment of the blades,

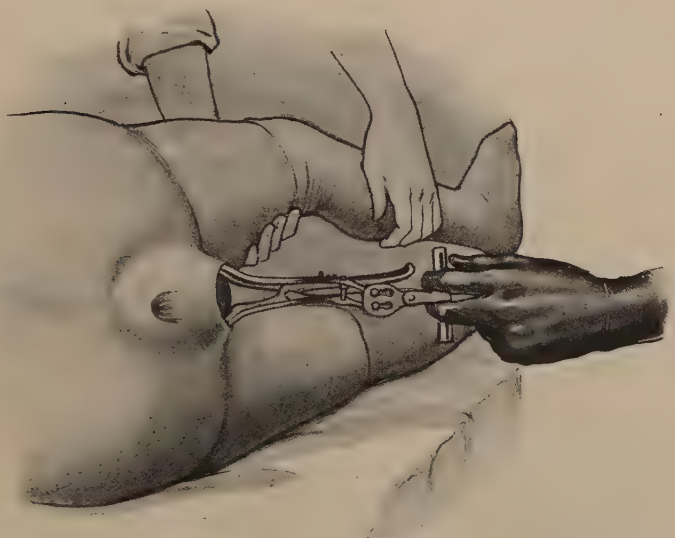


Fig. 367.—Delivery by Axis-traction Forceps. Traction in the direction of the axis of the pelvic cavity.

if not due to inexperience, usually results from a faulty position of the head. In occipito-posterior positions, when rotation has not occurred either forwards or backwards, there is often great difficulty in obtaining a satisfactory grip of the head when the blades have been applied, as described, in the transverse diameter of the pelvis. It has already been explained that such cases should, if possible, be treated by manual rotation before forceps is applied (see p. 304). When the head lies in an oblique diameter with the occiput forwards the difficulty can be overcome by applying the blades not in the transverse diameter, but in one of the oblique diameters of the pelvis, so that they grip the head in the bi-parietal diameter. Thus in a first position the left blade would be directed towards the left

sacro-iliac synchondrosis, the right towards the right pectineal eminence, so that the instrument would lie in the left oblique diameter, and would thus obtain a grip of the head in its bi-parietal diameter. In a second position the blades would lie in the right oblique diameter, the left blade being carried a little in front of the transverse, the right a little behind it. While traction is being made rotation will occur as the head comes down either in a forward or backward direction, according to the conditions previously discussed (p. 304).

Extraction of the Head.—Three points must be continually

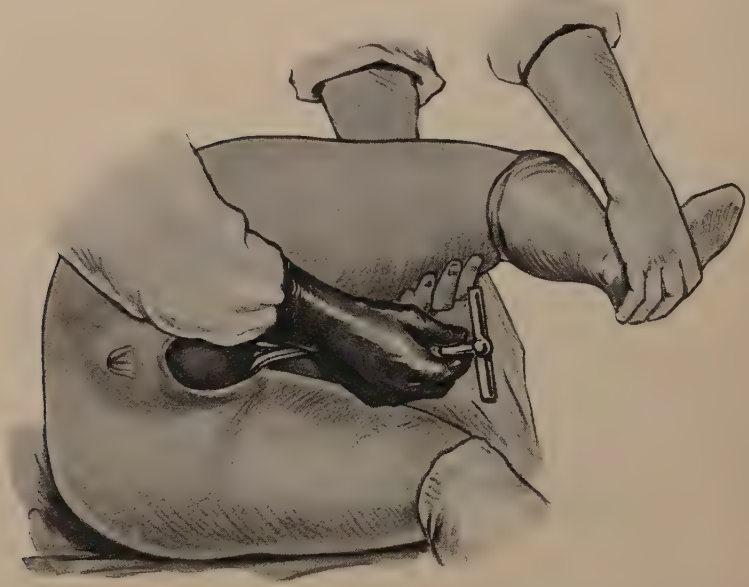


FIG. 368.—Delivery by Axis-traction Forceps. Traction in the direction of the axis of the pelvic outlet.

borne in mind in extracting the head with the axis-traction forceps : (1) to keep the traction rods always in contact with the shanks ; (2) to pull only during uterine contractions and to pause during the intervals ; (3) to ease the fixation screw whenever traction is not being made. In the low operation the direction of traction will be at first downwards, but as the head descends the application handles will of themselves move forwards, and the traction rods must be made to follow them (Figs. 367 and 368) ; if this point is carefully attended to traction will always be made exactly in the pelvic axis. Little or no time will be lost in pausing during the periods of relaxation

of the uterus, unless the patient is deeply anæsthetised, for the presence of the instrument in the genital canal powerfully excites uterine contractions. The object of easing the screw of the application handles is of course to avoid the risk of prolonged and continuous compression of the head. When the head and the pelvis are of normal size, the amount of force required with this instrument is small, and delivery can often be effected by making traction with two fingers only. If during traction the instrument should be felt to slip, it must be taken off and reapplied. When marked rotation of the head occurs during its descent, so as to bring the blades nearly or

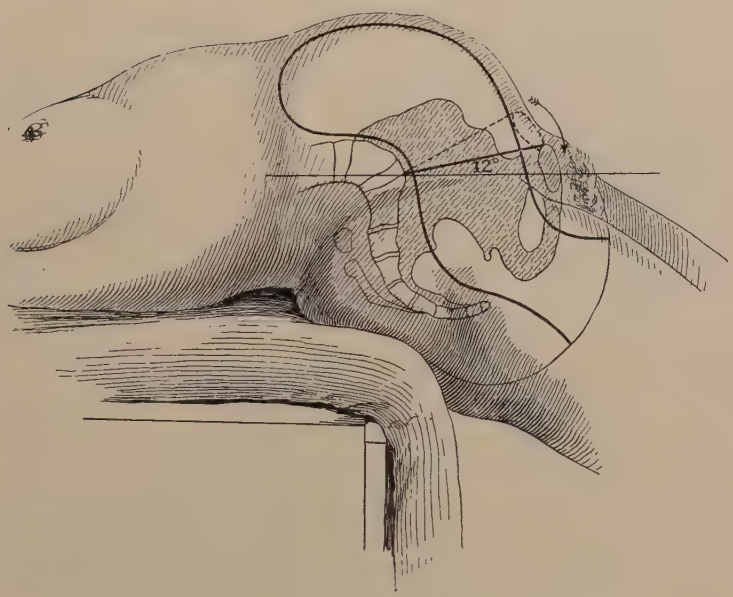


FIG. 369.—Walcher's Position. (Edgar.)

quite into the antero-posterior diameter, the instrument should be removed and reapplied, or serious laceration of the vulva may be caused by the edges of the blades. When using the lateral position in the final stage of extraction, the line of traction required is across the body of the patient, and the handles will come into a line almost parallel with the anterior surface of the pubes (Fig. 368). The instrument may now be gripped by the shanks with the right hand, and the delivery of the head slowly completed; or, when the head is almost "crowned," the forceps may be removed and the head delivered by expression. In removing the instrument the traction handle is first taken off, then the fixation screw loosened

and the traction rods disconnected from one another; the blades can then be separately withdrawn.

(*b*) *When the head is in the upper part of the pelvic cavity: 'mid' and 'high' forceps operation.*—In these cases a careful estimate must be made of the size of the pelvis and the relative size of the fœtal head. In the absence of uterine inertia, some degree of obstruction is the commonest cause of arrest of the head in this part of the pelvis. The presence of an unusually large caput, and of extreme cranial moulding, would also

FIG. 370.—The Axis-traction Forceps in Walcher's Position, showing the Direction in which Traction is made.

suggest that some degree of obstruction is present. Before applying forceps it is therefore desirable to endeavour to estimate the amount of pelvic space which is available. It is very difficult to measure the diagonal conjugate during labour when the head is firmly engaged in, or has passed, the brim. A careful bi-manual examination of the head, after the method of Müller (p. 388), should be made, so as to observe the size of that portion which still lies above the brim. If the greatest cranial circumference has not passed through, great difficulty in delivery with forceps will be experienced, and only in excep-

tional cases should it be attempted, and then only tentatively. If the pelvis is normal and the head of not more than average size, arrest in the upper part of the pelvis is usually the result of insufficiency of the pains. It is sometimes difficult in high cases to obtain a firm grip of the head, the forceps slipping as soon as traction is begun. This accident will usually be found to be due to non-rotation of an occipito-posterior position.

(*c*) *When the pelvis is contracted.*—If the pelvis is *flat* the head nearly always engages in the transverse diameter ; consequently in applying the forceps in that diameter an occipito-frontal grip of the head will be obtained. This grip is certainly more likely to cause cranial injuries, but does not increase the difficulty of delivery, since the compensatory increase occurs not in the bi-parietal diameter, but in a vertical diameter of the head. It is of no use to attempt the cephalic application of the blades in such cases, because the bi-parietal diameter is firmly wedged in the brim of the pelvis.

Having applied the blades, one or two tentative pulls should be made to make sure that the grip of the instrument is secure. The patient should then be placed in Walcher's position for the extraction of the head (Fig. 370). In this position the patient is placed upon her back, with the buttocks over the edge of the couch and slightly elevated on firm pillows. The couch or bed must be high enough to allow the lower limbs to hang over the end without touching the floor. The effect of the hanging position of the legs is to alter the angle of the plane of the brim so as to reduce its inclination to the horizontal, and also slightly to lengthen the conjugate diameter of the brim. This position will therefore allow of the easier delivery through the brim of a tightly fitting head. In pulling the head through the brim the line in which it must move will be nearly vertical, for the axis of the brim in its altered inclination is more nearly vertical than in the usual position. The operator sits upon the floor between the patient's thighs (Fig. 370). When the head has passed through the brim, the legs should be flexed and supported by assistants, while the operator changes the line of traction, directing it rather sharply forwards as the head reaches the outlet. If internal rotation now occurs, the forceps should be taken off and reapplied to avoid delivering the head in an oblique diameter.

In the *generally contracted pelvis* Walcher's position is not of the same advantage, since the whole pelvis is small, whereas in the flat variety the difficulty is solely or mainly at the brim. The difficulty of forceps delivery is accordingly greater in a generally contracted pelvis, and there is more risk of injury to the fœtus.

In the *funnel pelvis* great difficulty may be met with in delivering the head through the outlet. Whitridge Williams

has shown that Sims' position and the elevated lithotomy position are both of great service here, as they produce an

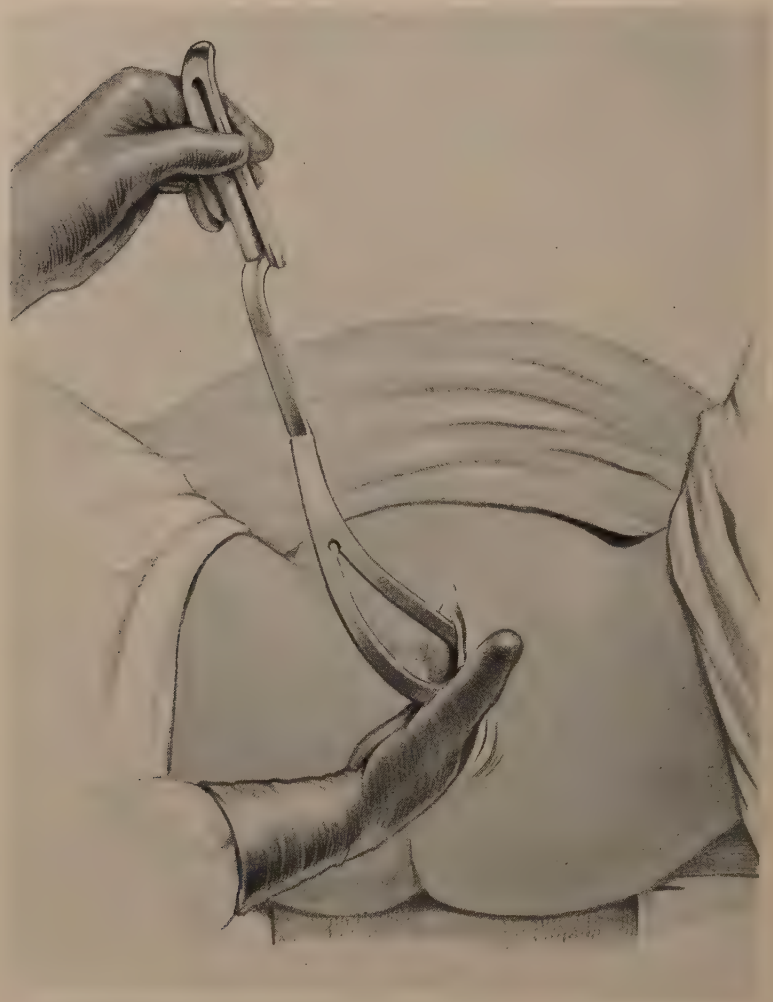


FIG. 371.—Application of Forceps in the Dorsal Position. Introducing the left blade.

The instrument used in Figs. 371 and 372 is an axis-traction forceps without the traction rods.

appreciable enlargement of the antero-posterior diameter of the outlet. In the elevated lithotomy position the patient is supported with a Clover's crutch, and the buttocks are further

raised above the level of the table on a firm pillow before the forceps is applied. The Sims' position is described on p. 286.

Application and Use of Ordinary Long Forceps.—The application of the blades is carried out in precisely the same manner as

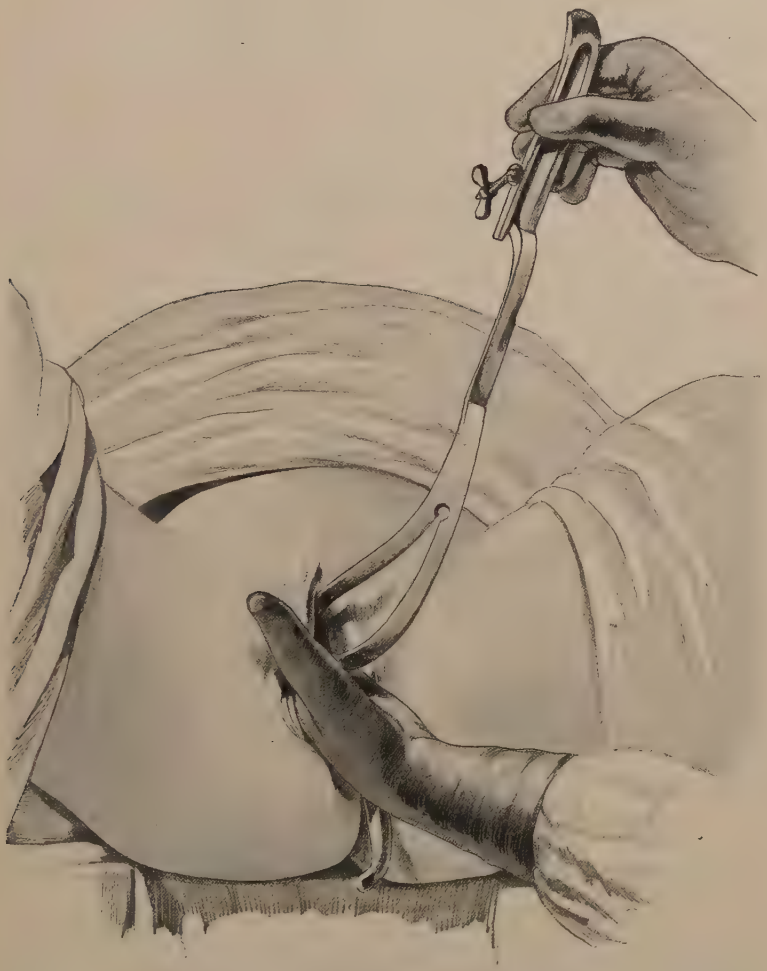


FIG. 372.—Application of Forceps in the Dorsal Position. Introducing the right blade.

the axis-traction forceps up to the locking of the handles; traction can then be at once begun. The same precautions in delivering should be observed; the firm grip of the handles, which is necessarily used when making traction, probably exerts more injurious pressure upon the head than does the

fixation screw of the axis-traction instrument; during the intervals the handles should accordingly be slightly separated without actually unlocking them, so as to diminish the pressure upon the head. Great care must be exercised throughout in directing traction as far as possible in the pelvic axis; the difficulties of effecting this have been already referred to.

When the indication for speed is urgent, as in forceps extraction of the after-coming head, this instrument is preferable, as it can be applied more rapidly. The blades of axis-traction forceps, without the traction rods, may be used as a substitute for the ordinary long forceps.

Application of Forceps in the Dorsal Position.—In cases of difficulty, such as an unreduced occipito-posterior position, or a contracted pelvis, the dorsal position will usually be found to allow of easier delivery with forceps than the lateral position. It is therefore desirable to become practised in the use of the instrument in this position. The operator stands between the flexed and abducted thighs, which are supported with a Clover's crutch or held by assistants. The left half should be passed first as shown in Fig. 371. The right hand is introduced into the vagina between the head and the left side of the pelvis and the blade is passed with the left hand; the blade is directed first of all backwards into the sacral hollow, and then into the transverse diameter, the handle being swept over to the right (of the mother) and then backwards on to the perineum. In introducing the right half, the operator's hands are reversed; the blade is passed *over* the left (Fig. 372), and then directed into the transverse diameter, the handle being swept over to the left (of the mother) and then backwards to meet the handle of the left half which has been already introduced. In the figures the instrument used is the axis-traction forceps without the traction rods. The presence of the latter undoubtedly renders the application of forceps in this position somewhat difficult, but the difficulty can be readily overcome by keeping the traction rods always below (*i.e.*, behind) the handles. In extracting the head through the outlet in this position it must be remembered that the direction of traction will be upwards and forwards, *i.e.*, towards the operator.

Forceps in Face Presentations.—In applying the instrument in these cases great care must be taken to avoid injuring the eyes. The blades are applied precisely in the same manner as in a vertex presentation, the grip of the head which will be obtained in mento-anterior positions being shown in Fig. 362 (3).

Application of Forceps to the After-coming Head.—This operation may be performed when the head is retained in the *pelvic cavity* and digital methods of extraction have failed; it is quite unsuitable when the head has not passed through the brim (p. 347). If the occiput is anterior, the body of the fœtus is

held forwards against the mother's abdomen, and the forceps applied in the usual manner behind it. Extraction will be easy unless the head is extended. When the occiput is posterior, the forceps must be applied in front of the body of the fœtus.

Risks of the Forceps Operation.—When strict antiseptic precautions are taken, when proper dilatation of the cervix has been previously secured, when the conditions are favourable as regards the relative sizes of the pelvis and the fœtal head, and when extraction is practised with care and skill, the forceps operation is devoid of any serious risk *to the mother*. In lying-in hospitals it is observed that the puerperal morbidity rate is definitely higher in forceps cases than in natural births. But this increase may well be due rather to the prolonged and difficult character of the labour in such cases than to the actual forceps operation. Serious lacerations of the cervix and vaginal vault, or of the vulva, may however be caused by inattention to the directions laid down for the use of the instrument ; lacerations in the former position are usually caused by performing the operation too early in labour ; in the latter position they may be caused by slipping of the blades, or by extraction after marked rotation of the instrument has occurred, or in delivering an unrotated occipito-posterior position. Attempts to deliver by forceps when there is insufficient pelvic space may cause serious lacerations, or from extreme or prolonged compression sloughing of some part of the vaginal wall may subsequently occur. Extraction performed too rapidly, or in the absence of uterine contractions, may lead to serious post-partum hæmorrhage. *To the fœtus* there is much more risk than to the mother : the *fœtal mortality* of forceps operations in a recent series at Queen Charlotte's Hospital was 79 deaths in 1,300 cases, a mortality of 6 per cent. as compared with a general fœtal mortality for all cases of 2·25 per cent. It must however be recollected that in many instances the death of the fœtus may have been due to the long and difficult character of the labour rather than to any actual injury inflicted by the forceps. A reference to the list of indications for forceps will make this clear. In fatal cases are frequently found such injuries to the head as fracture of the cranial bones, tears of the tentorium cerebelli and intracranial hæmorrhage, conditions which may lead to cerebral compression and asphyxia. Minor injuries, such as compression of the facial nerve (Bell's paralysis) and effusions of blood under the pericranium (cephalhæmatoma), may also be caused by forceps.

Cæsarean Section

This operation consists in the removal of the fœtus from the uterus by abdominal incision.

Historical.—Although Cæsarean section was practised upon the dead mother in very early times, and was indeed so prescribed by Roman law, it was not until the Middle Ages that the first operation was performed during life. The first recorded instance occurred about the year 1500, when a Swiss pig-gelder performed it upon his own wife. The first serious treatise upon the subject was published in 1581 by Rousset. From the sixteenth to the middle of the nineteenth centuries the mortality attending it was so high as almost to prohibit the operation; Lepage states that not a single case operated upon in Paris between 1799 and 1877 recovered. The general mortality even in the first half of the nineteenth century is known to have been over 50 per cent. There is no wonder that craniotomy and symphysiotomy were at this time strongly advocated as alternative procedures. One of the chief causes of the high mortality was that the uterine incision was not sutured, as at that time surgeons believed that ligatures could not be buried in the abdominal cavity owing to the risk of their suppurating; the immediate causes of death were, no doubt, hæmorrhage and sepsis.

An important modification of the operation of Cæsarean section was introduced by Porro in 1876. Porro's operation consisted of amputating the body of the uterus after the extraction of the fœtus, controlling the stump with a serrenœud, and fixing it in the lower angle of the abdominal wound. It was introduced as a means of preventing hæmorrhage and sepsis, and was not a momentary inspiration, but the outcome of much consideration and experiment upon animals. He advocated its general adoption in the place of Cæsarean section. The expectations raised by the new operation were not generally realised, but as its mortality, though very high, was lower than that of Cæsarean section in which the uterus was not removed (*Conservative* Cæsarean section), it enjoyed a few years of popularity. To Porro, however, belongs the great credit of having been the first to conceive the idea of removing the uterus after extracting the fœtus. Porro's operation became obsolete many years ago, but the principle of the removal of the uterus in certain cases has become well established, the method adopted being the modern one of intra-peritoneal hysterectomy, and the operation being nowadays known as *Cæsarean Hysterectomy*.

Six years after the introduction of Porro's operation Cæsarean section was revolutionised by Sänger's method of suturing the uterus. The first attempts to suture the uterus were made in 1835, but it was not until the introduction of Sänger's method, in 1882, that any satisfactory way of accomplishing it was devised. To this observer belongs most of the credit for the success which now attends the operation. Sänger's plan was

to employ two series of sutures—one deep, the other superficial; and no important modification of this method has since been introduced. The elaboration of antiseptic and aseptic technique during the last forty years stands next in importance to suture of the uterine wound as a cause of the low mortality of the operation at the present time, which, in the hands of skilled operators and under favourable conditions, does not exceed 2 per cent. Cæsarean section in its original form, in which the incision is made through the body or upper segment of the uterus, is now known as *Classical Cæsarean Section*, to distinguish it from certain modifications of the operation which have been introduced within recent years.

A method of extracting a full-time fœtus *per vaginam* by means of one or more deep incisions into the cervix was advocated by Dührssen in 1895, and named by him *Vaginal Cæsarean Section*. This consists in the application to obstetrics of the well-known gynæcological procedure of *vaginal hysterotomy* (p. 587). The operation has a very limited application. Still more recently, in order to overcome the risks of general peritonitis in infected cases, and of rupture of the scar in subsequent pregnancies or labours, various operations have been devised in which the incision is made into the lower uterine segment. This modification is known as *Cervical* or *Lower Segment Cæsarean Section*. Frank, in 1907, devised a method of opening the lower segment extraperitoneally. This operation, known as *Extraperitoneal Cæsarean Section*, was specially intended for use in cases in which the uterus had been infected, or was likely to have been infected, by previous unsuccessful attempts to deliver by the vaginal route. The technical difficulties of the operation are great, the bladder is liable to injury, and, although the risk of peritoneal infection is avoided, serious infection of the pelvic cellular tissue is likely to occur. This form of the lower segment operation has therefore not come into favour and is seldom performed. The form of lower segment operation which has come into greater favour, in a certain class of case, is that in which the lower segment is opened transperitoneally; it was originally introduced by Krönig, and its chief exponent in this country is Munro Kerr.

Indications.—Owing to the present low mortality of Cæsarean section, the indications for its performance have been considerably extended in recent years. It is now performed under most of the conditions which were previously held to necessitate craniotomy upon the living fœtus; while, owing to the uncertainty of the survival of the child after induction of premature labour, it is encroaching, as has been stated in another place, upon the field of this operation also. As regards the maternal risk, when performed on patients not in labour or on patients early in labour and unexamined vaginally, this is only frac-

tionally higher in Cæsarean section than in induction of labour ; and the chances of the survival of the child in the second degree of pelvic contraction are very much greater by Cæsarean section than by induction. It must, however, be understood that this operation is not justifiable in cases of slight disproportion in which labour may be expected to terminate spontaneously or with the aid of forceps, and in which the patient has not been given the benefit of the test of labour. In the case of patients seen for the first time when in labour, the alternative of craniotomy will sometimes have to be considered even when the fœtus is living. There is no doubt that it is better to perform craniotomy than to attempt to deliver a living child by Cæsarean section hurriedly undertaken, with insufficient antiseptic preparations, in insanitary surroundings, or by an operator unaccustomed to the technique of aseptic surgery. And further, it may be wiser to perform craniotomy than Cæsarean section when repeated unsuccessful attempts have been previously made to deliver through the natural passages, for, apart altogether from the possible risk of infection having occurred, the chances of the survival of the child, even if delivered alive by Cæsarean section, have been necessarily prejudiced by repeated and prolonged attempts to extract it with forceps through a narrow pelvis. Cranial injuries and cerebral hæmorrhage may thus be caused, from which the child will almost inevitably die in a few days, even if born alive. Inasmuch as the operation would be undertaken solely with the object of rescuing the child, the fact that its survival has been already gravely prejudiced must not be overlooked.

If there are any positive signs of infection having occurred, such as offensive smell of the liquor amnii, or fever associated with signs of illness or exhaustion on the part of the mother, the life of the fœtus should unhesitatingly be sacrificed, Cæsarean section in such a case being an extremely dangerous operation.

It is usual to divide the indications into *absolute* and *relative*. In the former a degree of obstruction is present which absolutely prohibits delivery by any method through the natural passages ; therefore Cæsarean section must be performed whether the fœtus is dead or alive ; in the latter, delivery by the natural passages, though perhaps difficult, is possible, and the operation is resorted to from choice, not necessity.

Absolute Indications.—(1) Extreme degrees of pelvic contraction, the conjugate diameter of the brim being not more than 2 inches, or the area of the plane of the brim not more than 2 × 4 inches (5 × 10 cm.).

(2) Insuperable obstruction from—

(*a*) Tumours of the uterus, such as cancer of the

cervix, and fibroids of the lower uterine segment or cervix.

(*b*) Other tumours, impacted in the pelvis, which cannot be removed by vaginal or abdominal section without first extracting the fœtus from the uterus.

(*c*) Tumours of the pelvic bones.

(*d*) Undilatable atresia of the cervix or vagina.

Relative Indications.—(1) Certain degrees of *pelvic contraction* or of *obstruction* from other causes, as an alternative to craniotomy, pubiotomy, or induction of premature labour. The class of pelvis which presents a relative indication for Cæsarean section is usually one in which the conjugate of the brim is from 2 to 3½ inches—4 to 8·75 cm. (see pp. 385—386).

(2) *Fibroid Tumours* which threaten to cause, or are actually causing, some degree of obstruction in labour. In addition to overcoming an obstruction, Cæsarean section gives an opportunity of dealing at the same time with the fibroid tumour. The ideal procedure is to enucleate the fibroids from the uterine wall (myomectomy) after extracting the child, and then to close the incisions and conserve the uterus. This is, however, not always practicable, and removal of the uterus must then be carried out.

Ovarian tumours obstructing labour may have to be dealt with by Cæsarean section. If the tumour is fixed in the pelvis, it may be impossible to separate and remove it without first reducing the size of the uterus by extracting the fœtus. The ideal procedure in such cases is to remove the tumour first, and later to deliver *per vaginam* without having to open the uterus.

(3) *Urgent maternal complications* sometimes call for delivery by Cæsarean section. Reference has been already made to its use in eclampsia, in placenta prævia, in accidental hæmorrhage, and in heart disease. In some of these conditions, *e.g.*, in eclampsia and in heart disease, the use of a general anæsthetic constitutes one of the chief risks of the operation, and one of the great objections to it. Some method of local anæsthesia should therefore be employed whenever possible; spinal stovaine anæsthesia is particularly suitable, for it has the added advantage that it assures good uterine contraction.

(4) Death of the mother, the operation being undertaken immediately after death for the purpose of extracting a living fœtus.

(5) A history of a previous Cæsarean section will generally suggest a repetition of this method of delivery in succeeding pregnancies. In the majority of such cases the original indication will still be present (*e.g.*, contracted pelvis), but in a certain number in which the operation was performed for some

urgent maternal condition this may be absent in succeeding pregnancies. It has been shown that although pregnancy and labour may pursue a normal course, there is a definite risk of rupture of the uterine scar.

Cæsarean section during labour should not be performed if the conditions indicate that the survival of the child is unlikely—*e.g.*, marked slowing of the fœtal heart (under 100), or fixation with marked moulding of the head in a contracted brim. In the former case it is very unlikely that the fœtus will be extracted in time to save it, since it has either been seriously injured or has become deeply asphyxiated; in the latter the extent of the injury the head has sustained is probably serious and the survival of the child doubtful. When, in addition to evidence of fœtal injury or asphyxia, there is a probability of infection having occurred, Cæsarean section must be held to be contra-indicated. To expose the mother to the increased risk associated with the operation under these conditions, when the survival of the child is already prejudiced, is not justifiable; the old obstetric principle should be followed that when the chances of life of the mother and those of the child are definitely conflicting the child should be sacrificed.

Indications for removing the Uterus.—After Cæsarean section removal of the uterus may be necessitated by the following conditions:

(1) Uterine infection. It is a wise precaution to remove the uterus whenever there is reason to believe that the uterine cavity has become infected. The reason for removing the uterus lies in the great risk of septic peritonitis which the mother runs if the infected organ is left. It is quite practicable, by careful technique, to avoid infecting the general peritoneal cavity with liquor amnii, etc., during the operation (*vide infra*). But if the uterine tissues are infected the incision in the uterus will not heal, infective material will pass into the peritoneal cavity, and general peritonitis will result. In some such cases localised suppuration has occurred between the anterior uterine wall and the abdominal parietes, resulting in a utero-parietal fistula. When infection of the parturient uterus occurs it is probable that the infection is not for long limited to the amniotic cavity, but rapidly spreads to the tissues of the uterine wall itself. The danger of peritoneal infection is therefore not confined to the operation, but remains when the uterus has been sewn up and returned to the abdomen. It is possible that further experience with the lower segment operation will limit the indications for this drastic procedure.

(2) Disease of the uterus, such as malignant or fibroid tumours, or malformation, for which hysterectomy would be indicated under any circumstances.

(3) The uterus may be removed along with the appendages in osteomalacia.

(4) When insuperable and incurable obstruction is present, for the purpose of preventing subsequent conception.

The Operation of Classical Cæsarean Section.—When it is necessary to perform the operation hurriedly, owing to the cause of obstruction being undiscovered until labour is advanced, the prognosis is distinctly less favourable than when sufficient time is available for proper preparations to be made. The gravity of the prognosis may be said, under such circumstances, to be influenced chiefly by the duration of labour and the risk of the uterus having been infected (see p. 659). We have here another illustration of the importance in pelvic contraction of making an accurate diagnosis of the *degree* of contraction, so that harm may not be done by resort to methods of delivery which cannot possibly be successful. Naturally also the longer the patient has been in labour the more unfavourable becomes the prognosis for the fœtus. It was formerly thought necessary to wait for the onset of labour pains and the commencement of dilatation of the cervix, but experience has shown that there is no advantage in so doing. When the operation is performed before labour has begun, some operators advise that the cervix should be artificially dilated until two fingers can be passed through the internal os in order to provide a channel for the free escape of the lochia. Experience has abundantly shown that this is quite unnecessary; the amount of lochia is usually small, and the after-pains which follow the operation accomplish all the cervical dilatation which is required. The prognosis is best both for mother and child when the operation is performed without waiting for the onset of labour, and when there is ample time for proper preparations to be made.

The *general preparations* necessary are those ordinarily required for abdominal section.

The *local preparations* include the vagina and the abdominal wall. Preparation of the vagina is unnecessary when the parts are healthy and labour has not begun; when labour has been already for some time in progress the canal should be disinfected as for a vaginal operation. Preliminary antiseptic douching is useful, but reliance must be placed chiefly on careful swabbing of the cervix and vaginal walls with tincture of iodine. This should be done with the aid of a speculum, and may be repeated immediately before the operation is begun. The surfaces must be wiped free from their secretions with pledgets of sterile cotton wool before applying the iodine.

The skin of the abdominal parietes should be sterilised from twelve to twenty-four hours before the operation, and carefully protected. When the operation is performed as an emergency,

the following method will suffice : After shaving down to the pubes the skin is well scrubbed with soft soap and hot water for

FIG. 373. Cæsarean Section. Extracting the fœtus by the feet ; the operator's left hand is assisting the delivery of the head ; the uterus is being steadied by the two hands of an assistant. (Protective Abdominal Towels are not shown in this and subsequent figures.)

five minutes, special attention being paid to the umbilicus ; the soap is then washed off with fresh hot water, and ether poured over the skin and rubbed in with a swab. When the skin is dry it is thoroughly swabbed with tincture of iodine.

Ether and chloroform are equally suitable for the anæsthetic. An intra-muscular injection of ergotin or aseptic ergot or of pituitrin may be made as soon as the patient is anæsthetised ; this will assist proper retraction of the uterus after its evacuation and will limit hæmorrhage. Before beginning the operation the presentation and position of the fœtus should be determined by palpation, and evidence obtained that it is alive, as Cæsarean section for ' relative ' indications is only justifiable when the fœtus is living. An extra assistant should be at hand,

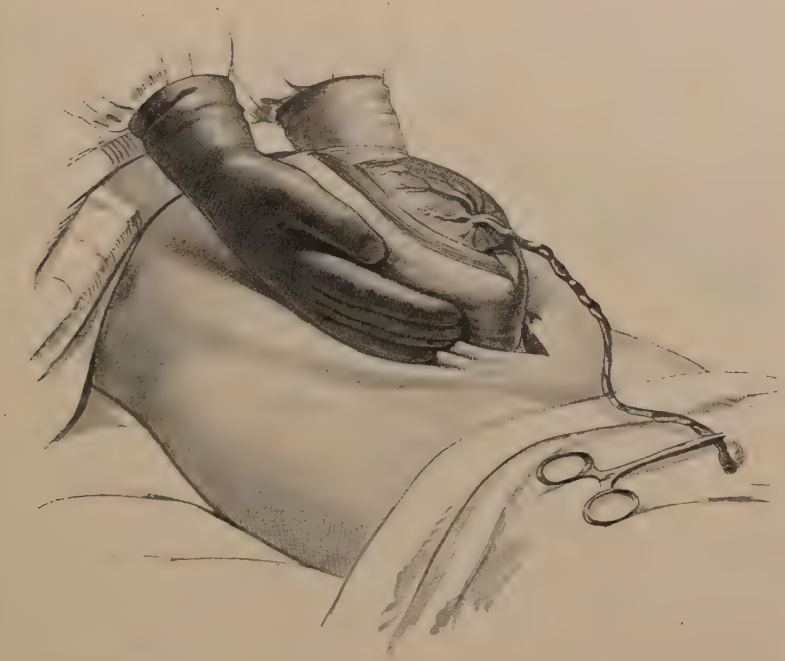


FIG. 374.—Cæsarean Section. The fœtus has been extracted, and the after-birth is being squeezed out of the uterus.

and a warm bath prepared, to resuscitate the fœtus if it should prove to be asphyxiated.

The *abdominal incision* should be made about 5 inches long in the middle line, starting about 2 inches above the umbilicus (Fig. 377). It will be recollected that the abdominal parietes at term are very thin, and the incision must be made with care, or all the layers may be unexpectedly divided by the first cut. Under normal conditions liquor amnii is sterile, and its escape need not be feared. When operating during labour precautions should be taken against peritoneal contamination by packing

gauze between the uterus and the abdominal wall all round the incision.

The *uterine incision* should be about 4 inches long, and as nearly as possible in the middle line of the uterus in order to avoid the more vascular lateral parts. It is therefore advisable to insert the hand and rotate the uterus if it is obvious that it lies obliquely. The uterine incision should be made to correspond with the upper 4 inches of the abdominal incision. Free hæmorrhage will usually occur, which, however,

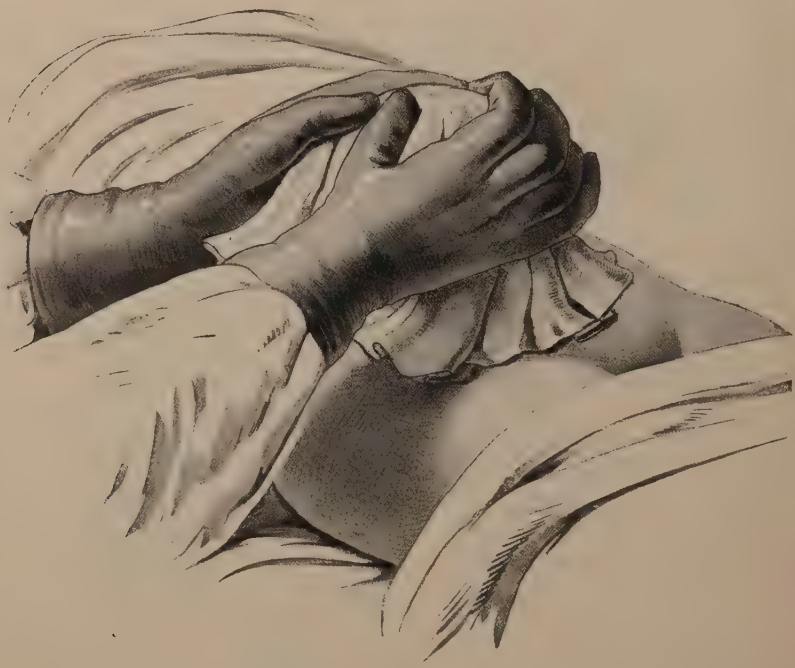


Fig. 375.—Cæsarean Section. Squeezing the uterus through a hot sterilised towel to promote contraction.

may be neglected for the moment. The membranes should be first exposed by a small incision, which can be extended by dividing the uterine wall upwards and downwards with scissors ; the amniotic sac is then opened and the hand passed to the breech, the position of which has been previously determined by palpation. The fœtus is then seized by the feet and delivered breech first (Fig. 373) ; the cord is immediately clamped and divided, and the fœtus handed over to the care of an assistant. If the placenta lies upon the anterior wall profuse bleeding will occur from the first cut in the uterus, but without pausing the

operator should tear through the placental tissues with two forefingers, or displace it to one side, open the amnion and extract the fœtus as rapidly as possible, when the hæmorrhage can be brought under control. Until the fœtus has been extracted the operator must work rapidly, for loss of time involves not only free bleeding, but also risks of fœtal asphyxia.

As soon as the fœtus has been extracted the operator's assistant passes his hand behind the fundus, turns the retracted uterus out of the abdominal wound, and squeezes it firmly in a hot towel to control bleeding. The intestines are then protected with sterilised towels or large swabs. After the uterus is felt to be well retracted the placenta and membranes are *carefully* and *completely* peeled off the uterine wall.

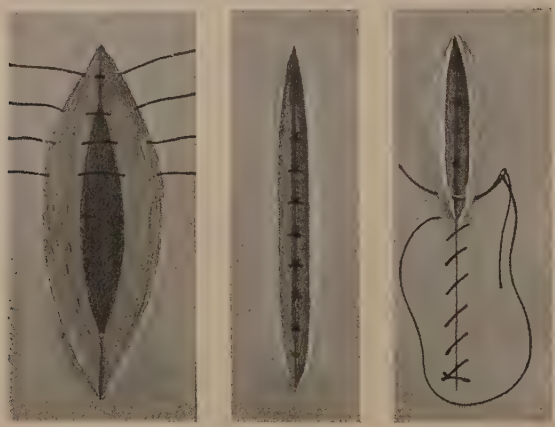
Closing the Uterine Incision.—Free hæmorrhage occurs from the cut surfaces of the uterine wall in which large venous sinuses and sometimes arteries of considerable size have been divided. This hæmorrhage can be temporarily arrested by wrapping up the uterus in a sterilised towel wrung out of hot saline solution, and then moulding it firmly between the hands as shown in Fig. 375. This produces fairly good retraction of the uterine muscle, by which the bleeding is to a great extent controlled; the effect lasts for two or three minutes, during which some sutures can be introduced, and the manipulation of the uterus can then be repeated if necessary. If the uterus fails to contract and retract well, the direct injection of pituitrin, $\frac{1}{2}$ c.c., into the uterine wall will have a remarkable effect.

As soon as the uterine wall has become thick from good retraction, the suturing of the uterine incision is begun; this is a very important step in the operation and must be carried out deliberately and carefully. A deep and a superficial layer of sutures are employed, the former interrupted and the latter continuous. The deep sutures include the whole thickness of the uterine muscle, but not the endometrium or the peritoneal coat. It is important to make these sutures include a good thickness of muscle; they are inserted with a curved needle, the point of which is made to enter just beneath the peritoneal coat and is passed well outwards to take a wide "bite," and is then curved inwards to emerge just above the endometrium; on its return journey through the opposite side of the incision the needle, of course, takes a reverse course (Fig. 376). These sutures are inserted at intervals of one third of an inch, and great care should be taken to ensure closure of the angles of the incision; they may be tied one by one as they are inserted or the whole series may be passed before they are tied. If after the deep sutures have been tied there is any undue gaping of the edges of the wound between them, a few intermediate sutures are

introduced, taking up as much of the muscle wall as possible. The incision is then closed by a continuous suture passing through the peritoneal coat and superficial muscle layer (Fig. 376); accurate coaptation of the peritoneal edges will prevent the formation of adhesions between the scar and the surrounding viscera and will diminish the chance of infected uterine contents leaking into the peritoneal cavity.

As regards the best suture material, there is general agreement that chromicized catgut is best for the superficial suture; for the deep sutures it is probable that stout silkworm-gut gives the best security and the firmest union, and is especially superior to catgut or silk in the presence of infection.

Closure of the Abdominal Wound.—The uterus is now returned



(*a*) (*b*) (*c*)

FIG. 376.—Closure of the uterine incision: (*a*) and (*b*), insertion of the deep interrupted sutures through the whole thickness of the muscle; (*c*) insertion of the continuous superficial layer.

to the abdominal cavity, and all blood or other fluid must be cleared away from the flanks and the pouch of Douglas, or wherever it may be found. Before returning it the uterus should be again firmly squeezed in a hot sterilised towel to expel any blood from the cavity which may have accumulated during the suturing of the incision. It is preferable, if possible, to sew up the abdominal wound in three layers, in the usual manner; but, owing to the thinness of the parietes, this is not always practicable. The peritoneum may then be closed with a continuous catgut suture, and the other layers, including the aponeurosis and the skin, taken up with interrupted silkworm-gut stitches.

The technique just described is suitable for all cases in which the operation is performed before labour, or early in labour, when there is no risk of infection having occurred. When the

operation is performed after labour has been already prolonged, or after unsuccessful attempts to deliver with forceps have been made, stringent precautions should be taken to avoid infecting the general peritoneal cavity when emptying the uterus. The technique of the operation should then be modified in the following manner :

The parietal incision should be prolonged upwards to a length of about 8 inches, when the entire uterus can be eventrated through it. The abdominal cavity is then carefully packed off with sterilised towels and large abdominal pads wrung out of warm sterile saline solution. Similarly the utero-

Fig. 377.—Cæsarean Section. The closed abdominal incision.

vesical pouch and lateral pelvic regions are packed, and the edges of the abdominal wound protected in the same manner. The uterus can then be opened by a median anterior incision placed rather higher up than that just described. After emptying the uterus the uterine cavity may be swabbed out with a 2 per cent. solution of iodine in spirit before the incision is closed. The surface of the uterus is next freely irrigated with normal saline solution, the packing is removed, and the uterus allowed to drop back into the abdominal cavity. Finally, the operator and his assistant put on a fresh pair of boiled rubber gloves, and a fresh set of instruments should be used in closing the abdominal wound.

Sterilisation of the Patient.—It is seldom justifiable to sterilise

a patient after conservative Cæsarean section. This operation has now been performed with success as many as seven times upon the same patient, and the risks attending it are so small that permanent mutilation in order to avoid the risk of a second operation should be discouraged. Pregnancy following Cæsarean section usually runs a normal course; in rare instances spontaneous rupture through the uterine cicatrix either before or during labour may occur (Figs. 274 and 381). Sterilisation is therefore rarely required, except for local incurable disease.

Sometimes, however, it may be necessary to sterilise a healthy woman from unwillingness on her part to undergo operation again. This may be accomplished either by removing the uterus or by removing the whole of both Fallopian tubes. The removal of the ovaries for this purpose is unjustifiable unless these organs are grossly diseased, or the patient is the subject of osteomalacia, for double oöphorectomy is often followed by serious consequences in women under forty-five years of age. The removal of the uterus is objectionable in women less than forty-five years of age, inasmuch as it permanently arrests menstruation. The removal of the Fallopian tubes has no influence whatever upon the menstrual functions. It is necessary to remove them in their entirety to ensure sterility, and to close the peritoneum over the stump at the uterine end. It has been shown that ligation of the tubes alone, or ligation and division, or even excision of a portion of the tubes, may be followed by conception through subsequent restoration of the tubal lumen.

The *after-treatment* of Cæsarean section is much the same as that of abdominal section generally. The skin sutures should be removed on the tenth day, and the patient should be kept in bed for two to three weeks. The amount of lochial discharge is usually small, and the involution of the uterus is not unfavourably affected. The patient is usually able to suckle her child, and should be encouraged to do so.

Lower Segment Cæsarean Section.—The lower uterine segment may be exposed and opened either transperitoneally or extraperitoneally. Frank, in 1907, in order to avoid the risk of peritoneal infection when opening the infected uterus by the classical method of Cæsarean section, devised *extraperitoneal Cæsarean section*, in which the lower uterine segment was exposed extraperitoneally through an incision above the symphysis and after displacing the bladder sideways. Owing to the technical difficulties of the operation, the risk of injury to the bladder, and the liability to severe infection of the pelvic cellular tissue, the operation has not found favour with obstetric surgeons and is nowadays seldom performed.

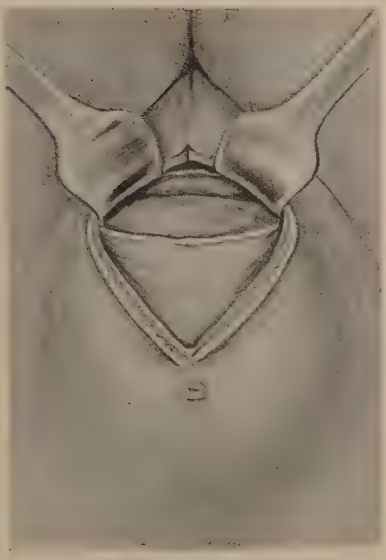


FIG. 378.

FIG. 379.

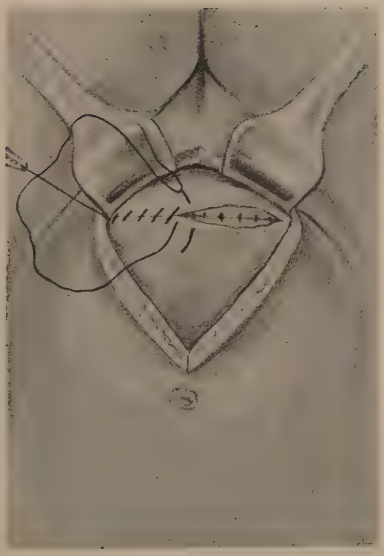


FIG. 380.

FIGS. 378—380.—The lower uterine segment incision (after Munro Kerr); Fig. 378. The peritoneum has been divided and the bladder pushed down, exposing the lower segment; Fig. 379. The lower segment has been incised transversely, and the head delivered; Fig. 380. The incision in the lower segment has been closed, and a continuous suture is being passed to unite the peritoneal flaps (protective towels are not shown).

The operation in which the lower segment is exposed transperitoneally has, on the other hand, now become well established; its technique and special indications will therefore be described.

The advantages claimed for the lower segment incision over the classical incision are as follows: (1) The uterine wound is covered in by a thick layer of utero-vesical fascia and by the bladder, and a perfect closure of the utero-vesical peritoneum can be made. For these reasons there is much less likelihood of infection spreading through the wound to the peritoneal cavity in infected cases. (2) The wound lies in the inactive part of the uterus and is at rest during the process of healing; there is, therefore, no tendency for the wound edges to be drawn apart by the after-pains or for gaps to be formed between the sutures. The wound, therefore, heals under more favourable circumstances than the wound after the classical operation, and there is less risk of a weak scar and its rupture on subsequent occasions. It is to be remembered that defective healing of the classical incision is especially liable to occur in infected cases. (3) The position of the wound is such that adhesions to the omentum, intestines and abdominal wall cannot occur.

The operation cannot be performed until labour has been in progress for some time and the lower uterine segment has developed; the more advanced the patient is in labour the easier will be the performance of the operation. The operation is therefore especially suitable for cases in which infection has occurred, or is suspected, as in cases of obstructed labour in which the membranes have been ruptured for many hours, or many vaginal examinations or unsuccessful attempts at vaginal delivery have been made.

The patient is placed in the Trendelenburg position and the abdomen is opened from the symphysis to just below the umbilicus. The utero-vesical peritoneum is incised from side to side and the bladder is dissected off the uterine wall, exposing the lower uterine segment (Fig. 378). A transverse incision is then made in the thin lower segment, slightly curved with the convexity downwards. A suture or a tissue forceps is placed on each end of the incision to control laceration in these directions and to pull up the wound after extraction of the fœtus so that it can be more easily sutured. The head of the fœtus is then expressed or is levered out with one blade of the forceps (Fig. 379). The wound is then sutured with catgut; the muscle is closed by interrupted sutures, and this layer is buried by a continuous suture through the divided utero-vesical fascia; the peritoneal edges are closed with a continuous suture (Fig. 380).

Cæsarean Hysterectomy.—This operation is performed in the same way as conservative Cæsarean section up to the point of extraction of the fœtus. The uterus may then be amputated

at the level of the internal os, or the whole organ, body and cervix, may be removed.

Supra-vaginal Amputation.—The ovarian vessels on each side are first secured with two ligatures, so as either to remove or to leave the ovaries, as may be desired ; in patients under forty-five both ovaries, if healthy, should be left. Then the round ligaments are similarly ligatured. The broad ligaments, first one and then the other, are clamped close to the uterine border, and divided between the clamp and the ovarian ligature down to the level of the internal os. Next an anterior peritoneal flap is turned down along with the bladder ; this allows the uterine arteries to be secured and divided at the level of the internal os close to the uterine wall. The uterus is then amputated ; after the uterine arteries have been tied and all oozing from the stump has been stopped by stitching the cut surfaces together, the peritoneal edges are united over it by a continuous suture running from one ovarian artery across the pelvic floor to the other.

Panhysterectomy.—This operation is performed in the manner just described up to the point of securing and dividing the uterine arteries. The cellular tissue is then pushed down all round the cervix until the reflection of the vaginal vault is reached. The anterior vaginal fornix is then opened with knife or scissors and the incision carried completely around the cervix, when the uterus, being freed, can be lifted out. All oozing from the cut edges of the vaginal wall must be carefully controlled ; a gauze pad is then pushed down into the vagina, and the peritoneum closed over it with a continuous suture from one ovarian artery to the other. The operations of supra-vaginal hysterectomy and panhysterectomy will be found more fully described in the text-books of Gynæcology.

Supra-vaginal amputation is preferred by most operators, but total hysterectomy will be required for septic infection of the uterus or for malignant growths of the cervix, and in some cases for fibroids.

Prognosis of Cæsarean Section.—The latest statistics of the mortality of Cæsarean section are those obtained by Munro Kerr and Holland, who, in 1921, organised a collective investigation into the results of Cæsarean sections performed in hospitals in Great Britain and Ireland during the years 1911–20 inclusive. First and foremost must be made the essential distinction between the mortality of the operation as performed on healthy women before the onset of labour and the mortality of the operation when performed in the presence of possible intrapartum sepsis, or for complications such as eclampsia, antepartum hæmorrhage, and so on. The true mortality of the operation *per se* is obtained by taking cases in which it was performed for contracted pelvis in healthy patients who were not in labour—in which, therefore, there was

no risk of intrapartum sepsis due to vaginal examinations, rupture of the membranes, or prolonged labour. In such favourable circumstances the operation is a particularly safe one in the hands of a skilful operator and in favourable surgical surroundings. But very remarkable is the progressive rise in mortality as the risk of intrapartum sepsis, or unfavourable state of the patient, increases. The following table shows the maternal mortality of Cæsarean section for contracted pelvis :

When performed.	Total cases.	Mortality.
Not in labour	1189 ...	1·4 per cent.
Early in labour	384 ...	1·8 „
Late in labour	213 ...	9·4 „
After induction of labour . .	35 ...	14 „
After attempts at delivery by forceps or craniotomy . . .	102 ...	26·5 „

The high mortality after cases long in labour, and especially

Fig. 381.—Drawing of section through middle of uterus with a ruptured Cæsarean section scar. Note: (1) Broad rounded edges of ununited muscle ; (2) the decidua covers these edges and reaches almost to the peritoneum ; (3) the narrow band of tissue between peritoneum and decidua on the right side, through which rupture has occurred ; (4) the overhanging flap of wide thin scar area, consisting of little else than peritoneum.

after attempts at delivery, is an indication of the risks likely to be incurred when the operation is performed under such circumstances ; but an immense factor for good or evil is, of course, the way the patient has been handled prior to operation, and whether examinations and manipulations have been made with strict aseptic precautions or otherwise. The maternal mortality of Cæsarean section is almost entirely due to septic infection, leading, as a rule, to general peritonitis ; pneumonia (probably of septic origin), pulmonary embolism, and postpartum hæmorrhage account for a few cases of death.

The fœtal mortality in cases in which forceps had been tried and failed amounted to 27 per cent. in the above series, and the early mortality of the infants who survived delivery was 11 per cent. The fœtal or infant mortality in such cases is from subdural cerebral hæmorrhage due to forceps pressure, or from excessive moulding of the head.

The *remote* prognosis of Cæsarean section concerns the liability to rupture of the scar in subsequent pregnancies and labours. This problem was investigated by Holland in 1920 from a collective follow-up investigation into over 1,000 cases of Cæsarean section performed by British obstetric surgeons between the years 1911 and 1918 inclusive. He found that rupture of the scar is liable to occur in 4 per cent. of patients who have had a classical Cæsarean section. The chief cause of rupture of the scar is imperfect healing of the uterine incision, leading to a thin scar in which muscular union has failed and which consists almost entirely of peritoneum and decidua, with a varying amount of intervening fibrous tissue (Fig. 381). Imperfect healing is due to infection of the uterine wound or to imperfect suturing. Such thin scars stretch during pregnancy ; in the recorded cases, rupture has occurred almost as often during pregnancy as during labour, and occasionally as early as the seventh month. No case has yet been reported of rupture of a scar in the lower uterine segment.

Vaginal Cæsarean Section.—This operation consists in deeply incising the cervix so as to allow of the immediate delivery of the child through the natural passages. Although anticipated by French obstetricians of the eighteenth century, the operation here described is of recent date, and was introduced by Dührssen.

The operation is performed as follows : The cervix is first exposed by two specula, then seized with two volsellæ, and pulled down to the level of the ostium vaginæ. A median incision is then made, beginning on the anterior lip of the os externum, and passing over the cervix and forwards on to the anterior vaginal wall to a point two inches above the urinary meatus. Through this incision the bladder is separated from the uterine and vaginal walls by blunt dissection. The peritoneum of the utero-vesical pouch is pushed up, but is not incised. A median incision is then made in the anterior wall of the cervix and carried upwards to the level of the internal os ; the cervix can be pulled down lower and lower during the process so as to keep the whole incision well within view. When the internal os has been incised the bag of membranes will present. Dührssen recommends that when the fœtus is at term the posterior fornix should be similarly incised and the posterior cervical wall divided up to a corresponding level. The uterine incision is carried a little above the internal os, and then the membranes are ruptured, and delivery effected by

podalic version. The uterine incision measures about 4 inches, so that it includes both cervix and lower uterine segment. After delivery of the placenta the cervix is again pulled down to the vulva and the deep incision closed with interrupted catgut sutures from above downwards. Finally, the incision in the vaginal wall is similarly closed.

This operation is difficult in a primigravida on account of the small size of the vagina and the rigidity of the perineum. It cannot be performed at term unless the maternal pelvis is of normal size, and up to the present time it has been chiefly applied to cases of eclampsia in which it was desired to deliver rapidly. The mortality is high, but it must be recollected that the maternal conditions for which it is undertaken are very grave. There is no doubt that at or near term the operation is one of much greater difficulty than the classical Cæsarean section, and it is very doubtful whether it has any advantages which compensate for these technical difficulties. If pregnancy has not exceeded the twenty-eighth week, and the patient is a multipara, the operation is comparatively simple.

Craniotomy, Decapitation, and Evisceration

These operations are designed to reduce the bulk of the fœtal head or trunk so as to allow of its extraction through the genital canal. Recent improvements in other obstetric operations have greatly restricted the indications for destruction of the fœtus *in utero*, and there is now a general agreement that the destructive operations should not be performed upon a living fœtus, unless the circumstances of the case render any alternative procedure positively dangerous to the life of the mother. They will, of course, continue to hold their position as the safest means of delivering a dead fœtus in certain degrees of pelvic contraction, or in other forms of obstruction or difficult delivery. In the case of a living fœtus the alternative procedures of Cæsarean section and pubiotomy should be carefully considered, and only when the circumstances of the case are such as to increase greatly the average risk of these operations can it be justifiable to destroy a living fœtus in order to deliver it.

A. **Craniotomy.**—This term includes the various methods of reducing the size of the fœtal head.

Indications.—(*a*) Obstruction of extreme degree, from pelvic contraction, from atresia, or from tumours of the soft parts, when the fœtus is dead or Cæsarean section is refused or is unlikely to succeed in saving the life of the fœtus. Unless the conjugate of the brim is at least $2\frac{1}{2}$ inches, extraction of a full-time fœtus is always very difficult and dangerous; if, however, as in a flat pelvis, the transverse diameter is relatively long, success may be obtained with a conjugate of rather less than $2\frac{1}{2}$ inches. It is generally agreed that craniotomy should not be attempted unless the pelvic brim measures at least 2 inches

by 4 inches (6·5 cm. by 10 cm.). (*b*) Conditions under which delivery by forceps or version would be practicable, but difficult, when the fœtus is dead. As examples may be mentioned, irreducible posterior positions of the occiput in vertex and breech, or of the chin in face, presentations. Craniotomy should always be performed when it is the easiest method of delivering a dead fœtus. (*c*) Malformations of the fœtal head, such as hydrocephalus.

When the indications for craniotomy arise, the patient's general condition has usually suffered from prolonged labour, and vaginal and perineal lacerations are also often met with from previous unsuccessful attempts to deliver with forceps. In these circumstances septic infection is liable to occur, and stringent antiseptic precautions should accordingly be taken. The vulva should be shaved, and the vaginal canal and vulva thoroughly cleansed, first with liquid soap and hot water and then with an antiseptic solution of moderate strength, such as biniodide of mercury 1—2,000, or lysol ℥j to Oj. The bladder should then be emptied by catheter. The operator should wear sterilised rubber gloves.

The operation of craniotomy consists of the two stages of (1) *Perforation ;* (2) *Extraction.*

(1) **Perforation.**—This stage consists in opening the cranial cavity and evacuating its contents, thereby allowing the vault of the skull to collapse under pressure. The instrument required is the *perforator ;* many varieties are obtainable, but the most useful is that of Oldham (Fig. 382). The blades of this perforator end in a sharp point, and are each furnished with an outer sharp cutting edge about 1 inch in length, ending in a projecting ridge or *shoulder.* The blades themselves are straight and furnished with strong handles, separated widely from one another when the blades are closed. When the handles are pressed together the cutting edges are forced apart.

In perforating the fore-coming head the parietal bone should be selected for the operation ; in the case of the after-coming head it is usually most convenient to perforate the occipital bone. In a face presentation it may be necessary to perforate the orbit. The instrument, with blades closed, is held firmly in the crook of the handles (Fig. 382, *a*), and the fingers of the other hand are passed up to the spot selected for perforation ; the instrument is then introduced along the palm of this hand, care being taken to protect the vaginal walls from the cutting edges. An assistant is required to immobilise the head by suprapubic pressure when it is not fixed in the brim. The point is then firmly pressed against the head, and by a rotary movement is made to penetrate the bone until arrested by the shoulders of the perforator. Care must be taken to prevent the point from slipping, the fingers of the internal hand keeping it

in contact with the head. The grip is then transferred to the handles, and as these are forced together the bone is lacerated by the cutting edges, two fingers of the internal hand being kept in contact with the shoulders (Fig. 382, *b*). The instrument is then closed, rotated through a right angle, and the bone cut again in a direction across the first. The head of the perforator can now be slipped inside the cranial cavity, and the brain,

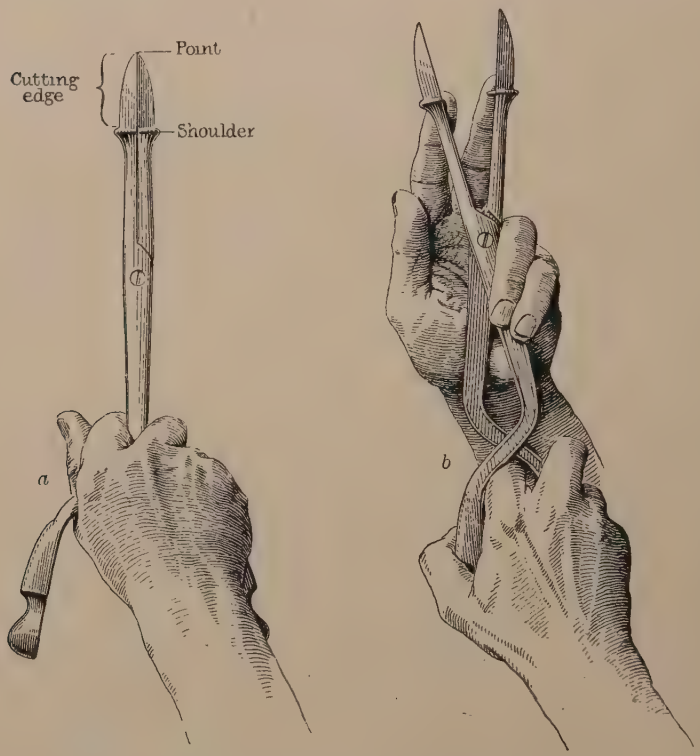


FIG. 382.—*a*, How to hold the Perforator when closed ; *b*, How to open the Perforator.

Note.—Gloves should be worn in using this instrument.

including the vital centres in the medulla, thoroughly broken up. It must be remembered that the strong tentorium cerebelli must be pierced in order to reach the medulla. By suprapubic pressure the greater part of the cranial contents can now be expressed, or they may be completely cleared out with the finger and a stream of boiled water if desired.

Perforation is an operation of great simplicity except in cases of non-engagement, when the head is so high up as to be difficult to reach with the fingers, and accordingly it is more difficult to

keep the perforator under control. Should the perforator slip, the uterine wall may be lacerated by the points, and in some instances injury to the sacrum has been caused in this manner. When, after an unsuccessful attempt to deliver with forceps, craniotomy is decided upon, the perforator should be used before removing the forceps ; this holds the head very steady, and after perforation it can sometimes be extracted with the forceps—*vide infra.*

(2) **Extraction of the Perforated Head.**—It is at this stage that much injury may be done to the mother. Extraction is difficult or easy according to the degree of pelvic contraction.

If the operation has been performed upon the after-coming head, traction on the trunk, combined with suprapubic pressure, will suffice for delivery of the perforated head, unless the degree of pelvic contraction is extreme, when crushing will be required.

With the fore-coming head extraction is more difficult, and five methods are available for selection according to the circumstances of the case : (*a*) delivery may be left to the natural forces of labour ; (*b*) the head may be extracted with the midwifery forceps ; (*c*) it may be extracted with the craniotomy forceps ; (*d*) it may be crushed and extracted with the cephalotribe ; (*e*) it may be extracted after removal of the bones of the vault (cranioclasm), in addition to crushing. The fœtus may also be delivered by version if the local conditions are favourable for this operation, and the conjugate measures at least 3 inches, the pelvis being flattened, not generally contracted ; but extraction by version is not to be recommended for general use, and should be reserved only for cases in which the practitioner has not got the requisite instruments for extraction by better methods.

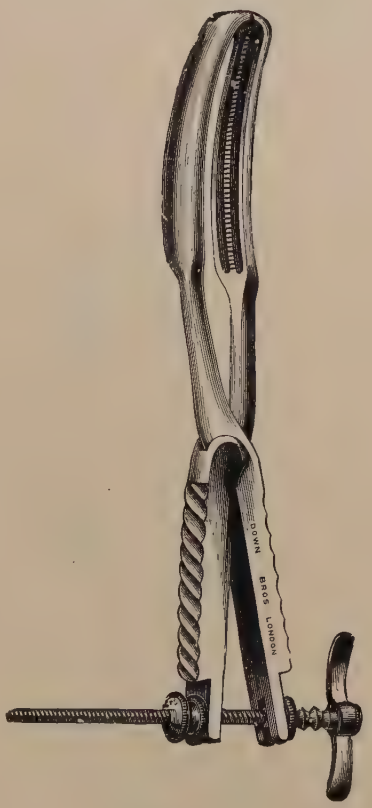


FIG. 383.—Cephalotribe of Braxton Hicks.

(*a*) *Delivery by the Natural Powers.*—If the mother's condition permits, and the amount of disproportion between the head and the pelvis is not great, the best course to adopt is to allow the natural powers to act on the collapsed head and gradually to mould and expel it ; thereby the risks of maternal injury are reduced to the minimum.

(*b*) *Extraction with the Forceps.*—When perforation is performed after the head has passed through the brim, and if the amount of pelvic contraction is slight, the head may be delivered with forceps. But the forceps is not very suitable for the purpose and is liable to slip off the collapsed head if more than moderate traction is required.

Fig. 384.—The Cephalotribe applied to the Head for Crushing.

(*c*) *Extraction with the Craniotomy Forceps* (*or Cranioclast*).—By this instrument (Fig. 385) a firm grip is obtained on the head, but as the amount of crushing action is very slight, it is only suitable for use in cases of moderate pelvic contraction. It consists of a pair of concavo-convex blades, the outer or larger of which is fenestrated, the smaller solid (Fig. 385); their apposed surfaces are strongly serrated. The handles are closed by a screw. It may be used for breaking up the vault of the skull (*cranioclasm*), as well as for *traction*. When used for traction, the small blade is passed into the cranial cavity through the perforation hole until it impinges on the base of the skull ; the outer blade is then applied either over the face, the occiput, or one or other parietal bone. The handles are then screwed tightly together and traction begun.

(*d*) *Extraction after Crushing* (*Cephalotripsy*).—When there is considerable disproportion between the head and the pelvis, the perforated head must be crushed before extraction. The operation is known as *cephalotripsy*, and its object is to reduce the size of the base of the skull, which is of course unaffected by perforation and collapse of the vault. Crushing and extrac-

tion may be considered together, because both are performed by the same instrument, the cephalotribe.

The best form of cephalotribe is that of Braxton Hicks (Fig. 386). It is a pair of very powerful forceps, the blades of which are thick and narrow, with a slight pelvic curve. When closed they are in contact by their incurved tips ; the maximum distance between them does not exceed $1\frac{1}{2}$ inches. The handles

FIG. 385.—Craniotomy forceps or Cranioclast.

FIG. 386.—Cranioclast applied to the Face after Removal of the Vault of the Skull.

are locked like the forceps, and furnished with a powerful screw, by means of which the blades can be forced together and the head crushed between them. The instrument is applied in the transverse diameter of the pelvis in the same manner as the forceps ; when the pelvis is flattened this implies that the head will be seized in the antero-posterior diameter, one blade passing over the face, the other over the occiput. This grip is the most secure which can be obtained and the most effective, inasmuch as the reduction in size which it produces is greater than where the head is gripped in any other diameter. If the

head is not engaged in the transverse diameter of the pelvis the grip of the instrument will be oblique, and not only less secure, but also less effective in reducing the size of the head. In the generally contracted pelvis the oblique engagement of the head and the relative narrowness of the transverse diameter of the pelvis render the use of the cephalotribe more difficult than in a flat pelvis.

On account of the narrowness and great weight of the blades, it is much more difficult to prevent them from slipping, and great care must be taken to direct each blade into its proper position and keep it there with the fingers. When the blades have been applied and the handles locked, the screw is adjusted and crushing begun. The blades are now liable to slip backwards off the head, unless care is taken to keep the instrument in the axis of the brim and retain the blades in their proper position in contact with the head. The screw should be slowly tightened until the handles are nearly in contact, while the internal fingers take note of the position of the blades. If the amount of resistance encountered by the screw is small, this generally means that the blades are slipping and the head is not being properly crushed. They should then be unscrewed and reapplied, care being taken to pass one of the blades well over the face, which usually gives a secure grip. When the handles have been well screwed together the crushing is completed.

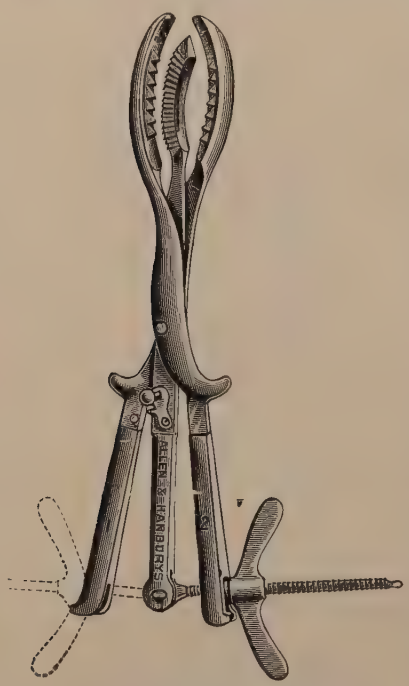


FIG. 387.—The Three-bladed Cephalotribe.

It will be observed that the crushed diameter of the head now lies in the transverse of the pelvis ; delivery will be facilitated in a flat pelvis if the instrument is rotated so as to bring the crushed diameter into the conjugate where the space is limited. The amount of pelvic curve on the instrument is slight, and does not contra-indicate extraction in the conjugate.

Before beginning the extraction the perforation aperture

must be examined and the edges of the scalp turned in over the edges of the bone, so as to avoid laceration of the vaginal walls by protruding spicules. Traction should always be made in the axis of the pelvis. The cephalotribe is a very powerful tractor, and at first great gentleness must be used until it is clear that the grip is secure. If traction does not cause the head to

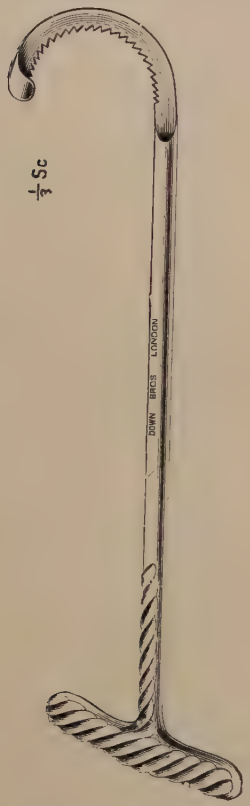


Fig. 388.
Decapitation Hook.

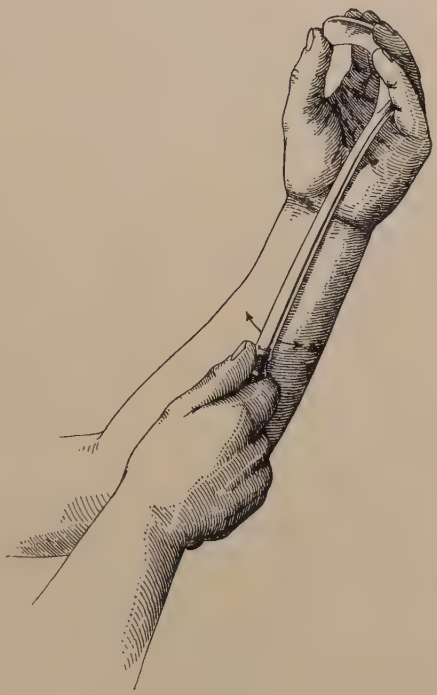


Fig. 389.
How to hold the Decapitation Hook.

advance, the blades are probably slipping. An antiseptic intra-uterine douche should always be given after crushing operations.

The application of the cephalotribe to the after-coming head needs no separate description.

A three-bladed cephalotribe has been introduced by Winter and modified by Auvard (Fig. 387). The middle blade, which in the best pattern has a screw-thread cut on its tip, is passed through the perforation aperture and screwed into the foramen magnum. This is held in position by an assistant, and the first outer blade is passed over the face ; these two blades are

then screwed up, thus crushing the anterior part of the head. The second outer blade is next passed over the occiput and screwed up to the middle blade. If the first outer blade is applied over the occiput, it will increase the flexion of the head, and this will prevent a satisfactory grip of the head being obtained. When properly applied the grip obtained is very firm, and the amount of reduction of the head is greater than that obtained by the ordinary cephalotribe.

(*e*) *Cranioclasm.*—This operation consists in the avulsion of the bones of the cranial vault, followed by crushing the remaining part of the head—*i.e.* the face. It is probably never really required unless the conjugate is reduced to $2\frac{1}{2}$ inches or less. It is seldom done nowadays because, with the progressive improvement in the standard of obstetrical knowledge amongst midwives and medical practitioners, cases of pelvic deformity so extreme as to require this operation are almost always recognised during pregnancy or sufficiently early in labour to permit of Cæsarean section being performed. Furthermore, the risks of maternal death or of terrible injury from craniotomy in such extreme cases are so great that Cæsarean section or hysterectomy is safer, and is therefore preferable even though the fœtus be dead.

The cranioclast or craniotomy forceps has already been described. When used for *breaking up the vault*, the small blade is passed into the cranial cavity, and the large one between the scalp and the bone ; the handles are then screwed up, and the portion of bone gripped by the instrument is twisted off and withdrawn. The process is repeated until the vault has been entirely removed. Extraction is then performed by first extending the head by combined vaginal and external manipulations, so as to produce a face presentation ; a sharp hook is then fixed in the jaw to steady the head, and the cranioclast applied over the face, the small blade being passed over the base of the skull, the large blade beneath the chin (Fig. 386). The bones of the face are then crushed, and the head, now greatly reduced in bulk, can easily be extracted.

B. **Decapitation.**—This operation may be required in impacted transverse presentations, with locked twins, or with double-headed monstrosities. The commonest indication for its performance is a transverse presentation in which unsuccessful attempts to deliver by version have been previously made.

It may be performed with a strong pair of curved scissors, but the safest instrument to employ is the decapitation hook (Fig. 388). The one generally used in this country is a wide hook with a blunt point and either a cutting (Ramsbotham's hook) or a serrated edge. The handle is sufficiently long for it to be used when the neck is at the pelvic brim. In a trans-

verse presentation, decapitation may be performed as follows : If an arm is prolapsed, traction can be made upon it so as to bring the neck down as low as possible. Careful exploration with the fingers having been made to recognise the position of the back and the side to which the head lies, the hook is introduced along the palm of the hand and guided upwards between the shoulder and the anterior pelvic wall (dorso-anterior positions) until the point lies above the neck. It is then rotated through a right angle so as to carry the cutting edge across the neck (Fig 389) ; the fingers are then passed up the ventral aspect of the fœtus so as to guide the point of the hook into position across the neck. Decapitation is performed by a sawing movement, the fingers of the left hand being kept in contact with the point of the hook to protect the maternal passages from injury. The soft fœtal bones are easily divided in this manner. After severing the head the trunk is delivered either by bringing down both arms or by podalic version. When the back presents, it is sometimes necessary to divide the spinal column, in addition to decapitating. If the pelvis is of normal size the retained head may be delivered by traction on the lower jaw with the finger passed into the mouth or with forceps ; it must be crushed with the cephalotribe, if the pelvis is contracted ; perforation is unnecessary, as the cranial contents will escape through the vertebral canal. In decapitating the after-coming head a long, strong pair of scissors will suffice.

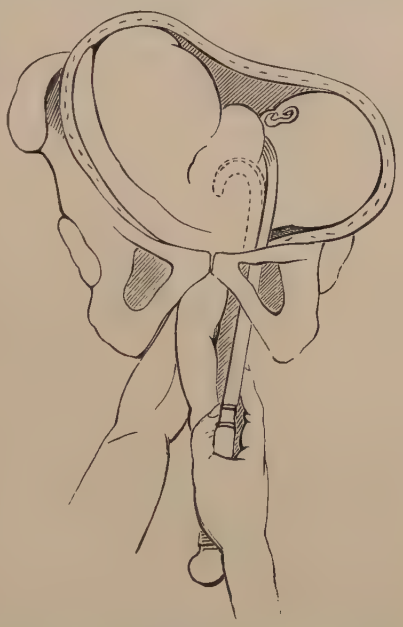


FIG. 390.—Introduction of the Decapitation Hook. (Barnes.)

Decapitation may be performed in a somewhat different manner by the use of Braun's hook (Fig. 391). This instrument is blunt, its crook very narrow and ending in a bulbous point. It is intended, not to cut through the neck, but merely to dislocate the cervical vertebræ. It is passed over the neck in the manner already described, and made to include the vertebral column ; the hook is then forcibly rotated, so as to dislocate

the vertebræ. The soft tissues are then divided with scissors. The advantage of this instrument is its small size.

In an impacted shoulder presentation the cord and an arm are usually prolapsed, and by the time the body of the fœtus has become impacted it has ceased to live. Even if feeble pulsation in the cord can still be felt, there is no possibility of delivering rapidly enough to save its life ; consequently delivery may be conducted solely in the interests of the mother. If the uterus is retracted, the lower segment distended and Bandl's ring palpable, decapitation is clearly indicated, for version would be attended with the gravest risks of rupture. If the conditions are not quite so unfavourable as this, the uterus may become sufficiently relaxed under surgical anæsthesia to allow of version being performed, but no unnecessary risk should be run if the fœtus is dead.

When the lower segment is markedly distended, even decapi-

Fig. 391.—Braun's Decapitation Hook.

tation is attended by a risk of rupture from the introduction of the fingers and the hook. Great care must be exercised, and if difficulty is encountered, decapitation should be abandoned in favour of evisceration.

C. **Evisceration.**—This operation consists in opening the abdomen or thorax with strong scissors in the most accessible position, and removing the abdominal and thoracic viscera piecemeal with the fingers. It may also be necessary to divide the spinal column before the trunk can be delivered. It is indicated in transverse presentation as an alternative to decapitation, and in cases of obstruction from abdominal or thoracic enlargement (ascites, cystic disease of kidneys, etc.).

D. **Cleidotomy.**—This operation consists in dividing one or both clavicles with a strong pair of scissors. Division of the clavicles is sometimes required when, owing to the large size of the trunk or the narrowness of the pelvic outlet, the shoulders cannot be extracted and the fœtus is dead.

Symphysiotomy ; Pubiotomy

The object of these two operations is to produce a temporary enlargement of the pelvis sufficient to permit the delivery of a

living child by the natural passages. As symphysiotomy is the older of the two, it will be described first, although nowadays it is seldom performed.

Symphysiotomy.—Symphysiotomy consists in dividing the symphysis pubis, and was not performed upon the living woman until 1774. Owing to the terribly high mortality of Cæsarean section at this period, symphysiotomy was at first frequently performed ; but it soon fell into disrepute and was almost abandoned, as the results were no better than those of Cæsarean section. More recently it has again been advocated by Morisani, of Naples, and Pinard, of Paris, but is not generally regarded with favour owing to the extremely limited scope of its application and the comparatively unfavourable results which it still shows.

The effects of division of the symphysis upon the pelvic diameters are not entirely clear. When, in the cadaver, the pubic bones are separated, a considerable amount of strain is placed upon the anterior ligaments of the sacro-iliac synchondroses, and these structures may suffer serious injury ; in addition, rotation of the innominate bones round a transverse axis passing through these joints occurs, which carries the pubes downwards as in Walcher's position (Fig. 369) ; lastly, a slight movement of rotation of each innominate bone round its own long axis occurs, which slightly increases the distance between the ischial tuberosities. The pubic bones must not be allowed to separate for more than $2\frac{1}{2}$ inches (Budin and Demelin), or rupture of the sacro-iliac ligaments will occur. This degree of separation increases the conjugate of the pelvic brim by about one-third of an inch, the increase being relatively rather greater in a markedly contracted pelvis than in one only slightly contracted. The oblique diameters of the brim are increased about twice as much, and the transverse about three times as much, as the conjugate. The marked increase obtained in the transverse diameter is, however, of little use without a corresponding increase in the conjugate.

Indications.—It is obvious from the above that symphysiotomy can only be applicable to cases of slight disparity between the size of the fœtal head and that of the pelvis. It may be performed when the head is delayed at the brim in a flat or generally contracted pelvis, or at the outlet in a funnel pelvis, careful examination having shown the degree of disparity between the pelvis and the fœtal head to be small. It may be preferred to Cæsarean section in cases of this kind when labour is advanced, and repeated attempts to deliver by other means have already been made. But if the passages have become infected during labour, symphysiotomy is attended by grave risks of septic infection of the wound ; and although this does not communicate with the genital canal, serious and even fatal

results may follow from the spread of the infection to the pelvic cellular tissue and the vesical venous plexuses.

If the fœtus presents by the breech, it is impossible to estimate the relative sizes of head and pelvis until the body is born, when there is no time to perform symphysiotomy; therefore the operation is only of use in head presentations.

The Operation.—*Preliminaries.*—The time for performance of the operation is at the end of the first or early in the second stage of labour. The operator must, of course, satisfy himself that the fœtus is alive. The pubes should be shaved and the abdominal wall and vulva disinfected. The operator requires three assistants, two of whom will support the thighs of the patient, who should be placed in the dorsal position, with the buttocks over the edge of the bed or operating table.

The operation may be performed by the *open* or the *subcutaneous* method.

Open Method.—An incision 2 or 3 inches long is made in the middle line from a point just above the pubes to the lower border of the symphysis, avoiding the clitoris; this incision passes down to the bone, and in its upper part exposes the aponeurosis. By blunt dissection the clitoris is pushed downwards, and its suspensory ligament then separated from the pubes by cutting through it with scissors. The index finger is next passed behind the symphysis, and worked downwards in the cellular tissue until the lower border is reached. The operator then divides the fibro-cartilage of the symphysis with a probe-pointed knife from above downwards, great care being taken not to injure the urethra. The pubic bones now separate spontaneously, and the two assistants in charge of the legs have an important duty to perform in preventing a dangerous amount of separation. The fœtus is best delivered at once with the forceps; great care must be exercised, for if much force is exerted serious injury will be done to the pelvic joints and the urethra. The wound is then closed with four or five deep silkworm-gut sutures, and an antiseptic dressing applied. It is unnecessary to suture the bones, but a tight pelvic binder is applied in such a position as to immobilise the innominate bones and thighs. A catheter should be passed immediately after the operation to make sure that the urethra has not been injured; if laceration has occurred a soft rubber catheter should be tied in for forty-eight hours.

Subcutaneous Method.—A small incision down to the bone is first made with a tenotomy knife in the middle line just below the clitoris, which should be pulled upwards as much as possible. A curved probe-pointed bistoury is then inserted under the soft tissues and passed upwards nearly to the upper border of the symphysis, cutting into the front of the cartilage. The index finger of the left hand is then passed into the vagina and carried

upwards until the blunt point of the knife is felt above the symphysis. The division of the cartilage is then made from above downwards, the resulting separation of the bones being observed by the finger in the vagina. A sound should be passed into the bladder and the urethra displaced as much as possible to one side during the operation. The fœtus is then delivered and the operation completed by the application of an antiseptic dressing and a pelvic binder.

Although symphysiotomy is an easy and simple operation, its results are disappointing, for the following reasons: (1) injury to bladder and urethra often occurs; (2) the space behind the pubic bones (*cavum Retzii*) is difficult to drain, and when accumulations of fluid occur there they easily become infected; (3) the wound through the cartilage is very prone to infection, and may heal imperfectly.

Prognosis.—Statistics of this operation, compiled by Munro Kerr from 275 cases by well-known operators, show a maternal mortality of 6·5 per cent. and a fœtal mortality of 10 per cent. That is to say, the mortality is greater both as regards the mother and the fœtus than that of uncomplicated Cæsarean section. The complications most likely to be met with are injuries to the urethra or bladder and septic infection of the operation wound. Firm union of the symphysis usually occurs, but some cases of temporary and some even of permanent lameness have been reported.

Pubiotomy.—This operation resembles symphysiotomy in its general features, and the indications for its performance are the same. Instead of dividing the symphysis pubis, the body of the pubic bone is divided about $\frac{1}{2}$ to $\frac{3}{4}$ of an inch to one or other side of the joint. Pubiotomy possesses definite advantages over symphysiotomy; there is less hæmorrhage and less risk of injury to the urethra and bladder; it is claimed also that this operation allows of greater increase in the diameters of the brim than symphysiotomy, and further that the pelvis is *permanently* enlarged by it. Whitridge Williams has shown that the effect of pubiotomy upon the diameters of the outlet is well marked also, and that the operation is therefore serviceable in the funnel pelvis. He observed a *permanent* increase in the transverse diameter of the outlet of from 1 to 3 cm. in funnel pelves which had been subjected to this operation.

Although the operation is not difficult of performance, the proper selection of suitable cases is not so easy, and requires more than ordinary experience and judgment. It seems likely to come into favour for a limited class of case. The opinion of Whitridge Williams is that the operation is chiefly indicated in cases of slight disproportion in which natural delivery is anticipated, but in which the test of several hours of labour demonstrates that the head will not pass through the pelvic

brim. In such cases the application of high forceps is not permissible and the mortality following Cæsarean section may be expected to be high, whereas the mortality from pubiotomy should not be more than 1 per cent.

Pubiotomy may be performed by the open or the subcutaneous method. The position of the patient and the number of assistants are the same as for symphysiotomy. In the *open method* a transverse incision about $1\frac{1}{2}$ inches long is made inwards from the pubic spine and just above the upper margin of the pubic bone. The incision may be made upon either side. The tissues are divided down to the bone and the periosteum is then incised and separated from the posterior surface. A special pubiotomy needle (Fig. 391) is then entered above between the periosteum and the bone, directed behind the bone by the finger and guided below it and in front, until the tip of the needle is felt through the upper and outer part of the labium majus. A Gigli's saw is then passed and the bone

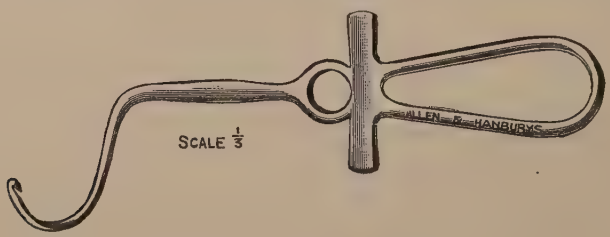


FIG. 391.—Pubiotomy Needle.

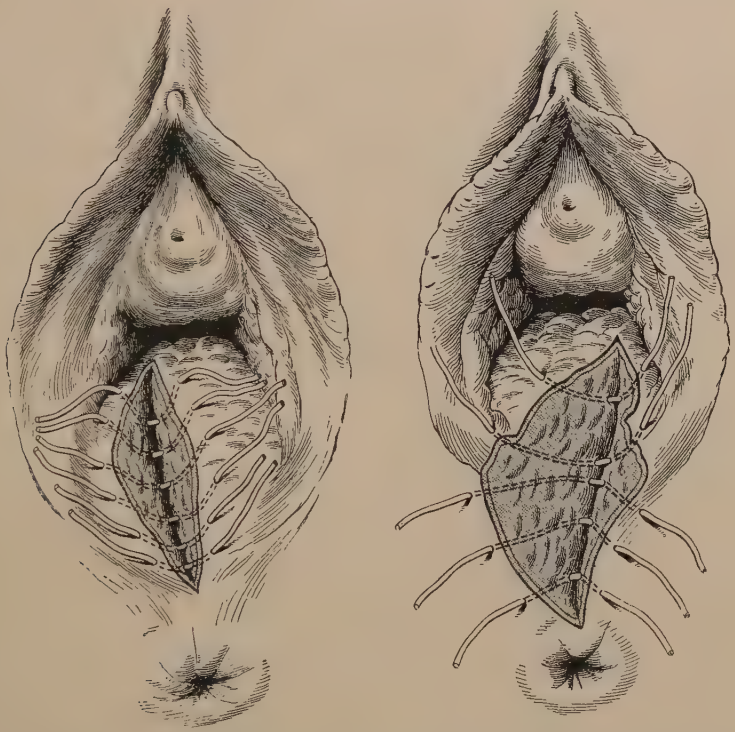
divided. Free hæmorrhage may occur from both wounds, but is readily checked by pressure. The fœtus is then delivered with forceps, or its spontaneous delivery may be awaited. As soon as the bone is divided the ends become slightly separated and become more widely separated during the delivery of the head. To prevent undue separation, the assistant on each side makes firm pressure on the thighs; but if the case has been properly selected, injurious separation need not be feared. After delivery the upper wound is sutured and dressed, and a firm binder is secured round the hips. The patient is kept in bed for fourteen days.

In the *subcutaneous method*, which is much inferior to the open method, a small incision, about an inch in length, is made just above and internal to the pubic spine, and the pubiotomy needle is passed behind the bone and made to emerge below the pubic arch by piercing the soft tissues in that position. Through the needle a Gigli's saw is threaded, and is drawn up behind the bone and brought out at the suprapubic incision.

The late results of pubiotomy are not unfavourable. The

bones reunite by fibrous union only, but this does not interfere with locomotion, and a certain amount of permanent increase in the pelvic diameter has been repeatedly observed.

The operations of symphysiotomy and pubiotomy have not been extensively adopted in this country, although several short series of cases have been recorded by British operators. Conditions in which they are indicated can also be dealt with by



a *b*

FIG. 392.—Perineal Laceration : *a*, First Type. *b*, Second Type. (Edgar.)

Cæsarean section, and this operation is usually preferred for the reasons already stated.

Primary Repair of the Perineum

All obstetric lacerations of the perineum exceeding $\frac{1}{2}$ inch in depth should be sewn up immediately. Such lacerations heal well if repaired at any time within forty-eight hours after delivery. Primary union can be obtained if surgical cleanliness is observed ; but when lacerations are allowed to remain

unsutured they frequently become infected during the puerperium, and may later on lead to the occurrence of prolapse or rectal incontinence.

Three types of laceration may be described. In the *first*, which is usually overlooked, the laceration at first sight appears to implicate only the anterior edge of the perineal body; if, however, the vulva is held open with the fingers, it will be seen that a comparatively deep laceration runs upwards and somewhat outwards into the vaginal wall on one or both sides (Fig. 392(*a*)). If this apparently trivial tear is neglected, it may lead subsequently to the condition of relaxed vaginal outlet and prolapse of the vaginal walls, for it is frequently deep enough to affect the posterior fibres of the levator ani and the anal fascia, which support the posterior vaginal wall. It should be repaired with interrupted catgut stitches, as shown in the figure.

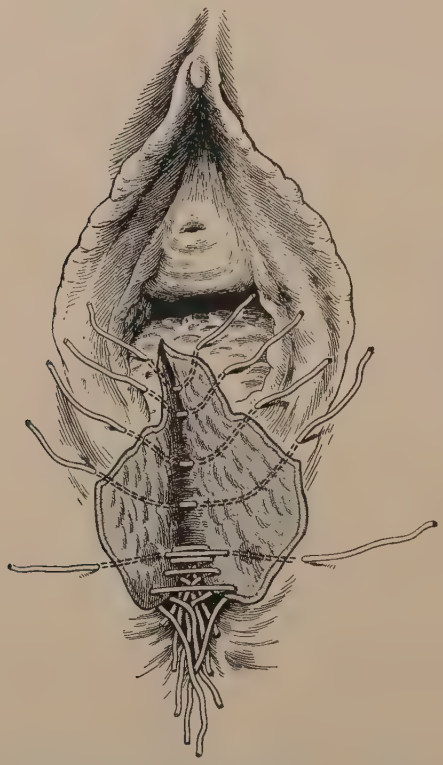


FIG. 393.—Perineal Laceration: Third Type. (Edgar.)

Note that the skin suture has passed through the torn ends of the sphincter ani muscle.

In the *second* type the laceration implicates the greater part of the perineal body and a considerable part of the posterior vaginal wall, but the anus and its sphincter escape. This type is sufficiently obvious to be generally recognised and sewed up. It is best repaired by a series of sutures introduced some through the perineum and some through the posterior vaginal wall (Fig. 392(*b*)); this is preferable to passing them all through the perineal surface and endeavouring to include the upper end of the vaginal rent, for accurate apposition of the edges of the vaginal mucous membrane, so necessary for a good result, cannot be obtained in this way. Strong catgut is the best suture material.

In the *third* type posterior vaginal wall, perineal body, and

anus are all torn through, establishing direct communication between the vagina and rectum (Fig. 393). This severe laceration requires very careful treatment, or the patient will suffer from incontinence of fæces. The edges of the rectal mucous membrane are first carefully united by a series of interrupted catgut stitches, which must be tied on the rectal side. Then the torn edges of the posterior vaginal wall are united in the same manner; and lastly deep sutures of silkworm-gut are passed through the perineal surface, the lowest of which should include the divided and retracted ends of the sphincter ani muscle.

When the delivery has occurred with the patient under the influence of an anæsthetic, perineal sutures may usually be introduced immediately, before the anæsthesia passes off, without waiting for the expulsion of the after-birth. The sutures should be clamped in position by artery forceps and only knotted when the after-birth has been delivered, otherwise, if digital removal of the placenta should become necessary, the operation would have to be repeated. This saves giving more anæsthetic in order to pass the sutures when the third stage is over. In severe lacerations into the rectum, it is better to wait until after the delivery of the placenta before beginning the operation, as considerable time is required in passing the sutures.

The patient should be placed in the lithotomy position, and the parts well exposed, for accurate suturing is essential. The Vaginal Retractor of Jayle shown in Fig. 324 is of great service in exposing the upper limit of the laceration; this allows the sutures to be introduced with accuracy and the edges of the torn vaginal wall to be properly brought together. Although considerably bruised and torn, the parts heal well if properly adjusted with stitches.

Part IX

The Maternal Mortality of Childbirth

The annual reports of the Registrar-General for England and Wales reveal the fact that the toll of child-bearing on maternal life is a very heavy one, and that about 3,000 women per annum die from the complications of pregnancy or labour. It is interesting to compare childbirth with other important causes of mortality. If this is done, it will be found that the consequences of child-bearing rank third amongst women between the ages of fifteen and forty-five. The year 1913 may be selected as an example, as a normal year unaffected either by serious epidemic disease or by the disturbances of war ; in this year 38,410 women (of whom 22,256 were married women) in this age-group died, and the chief causes of death ranked as follows :—

Tuberculosis in some form	11,986
Organic disease of the heart	3,838
Accidents and diseases of childbirth	3,456
All forms of cancer	2,812
Pneumonia	1,803

The maternal mortality-rate for the past thirty years may be studied from the following table (in which the years are arranged in groups of five).

1891–1895	...	Maternal mortality	5·5	per	1,000	live-births.
1896–1900	...	,, ,,	4·7	,,	,,	,,
1901–1905	...	,, ,,	4·3	,,	,,	,,
1906–1910	...	,, ,,	3·7	,,	,,	,,
1911–1915	...	,, ,,	3·8	,,	,,	,,
1916–1920	...	,, ,,	3·9	,,	,,	,,

The figures for three later years are : 1921, 3·7 ; 1922, 3·6 ; 1923, 3·6.

It will be noticed that an appreciable fall occurred during the quinquennium 1906–1910, but that since then the rate has remained fairly constant.

The maternal mortality-rate as returned by the Registrar-General is reckoned as the *number of deaths per* 1,000 *live-births ;* but it should be noted that amongst the deaths are included not only the women who die as the result of giving birth to living children, but also those who die as the result of pregnancy or labour ending in abortion or dead-birth.

The Causes of Maternal Mortality.—The most important causes are, in order of frequency: (1) puerperal infection, (2) the toxæmias of pregnancy, (3) ante-partum and post-partum hæmorrhage, (4) the "accidents" of childbirth. For further details a recent year may be selected, and the following table shows the figures for the year 1922, as computed by the Registrar-General from death certificates.

Cause of Death.	Number of Deaths.
Abortion	92
Ectopic gestation	86
Other accidents of pregnancy	132
Ante-partum and post-partum hæmorrhage	390
Other accidents of childbirth	304
Puerperal sepsis	1,079
Phlegmasia alba dolens	54
Embolism and sudden death	242
Albuminuria and eclampsia	556
Not assignable above	30
Puerperal diseases of breast	6
Total	2,971

The high maternal mortality of child-bearing is a matter of grave national and social concern, especially when it is remembered that these women are in the prime of life and are actively engaged in bearing and rearing children for the nation. The absence of any appreciable decline in the deaths from puerperal infection has already been noted (p. 497). Throughout this book the student has been instructed how to prevent the various complications of pregnancy and labour, and how best to manage them when they arise. Nearly all these complications are preventable, and preventive methods are therefore far more important than curative methods for reducing maternal mortality. The great importance of the systematic supervision of *all* pregnant women by the methods of *ante-natal supervision* will shortly be described.

Maternal Ill-health following Childbirth

The number of deaths by no means represents the entire maternal penalty of childbirth, for the number of mothers permanently injured or invalided greatly exceeds the number of deaths. The invalidism which may result from childbirth is divisible into two groups: (1) Affections of the pelvic viscera and genital tract; (2) General or medical disease.

(1) *Affections of the Pelvic Viscera.*—A great mass of minor gynæcological disease results from abortion and labour; it forms what may be termed "the gynæcology of obstetrics," and is observable in any gynæcological out-patient department. It may be grouped into (*a*) unhealed lacerations of the perineum, complete and incomplete, (*b*) severe lacerations of the cervix,

(*c*) prolapse of the uterus and vaginal walls, (*d*) retroflexion of the uterus of puerperal origin, (*e*) the after-effects of puerperal infection, viz., chronic salpingitis, sealed and adherent tubes, the scars resulting from pelvic cellulitis, (*f*) chronic subinvolution of the uterus, (*g*) fistulæ. None of these conditions can be said to produce serious illness, but they cause a great deal of chronic disablement and invalidism. They are important causes of sterility, abortion, menstrual disorders, uterine discharges, backache and pelvic pain, and they incapacitate many women from household duties and industrial work.

(2) *General or Medical Disease.*—There is a large amount of general debility after childbirth, especially amongst women of the working class, who cannot allow themselves a sufficient period of convalescence. Wide and persistent separation of the rectus abdominis muscles, and general visceroptosis, are not uncommon. Albuminuria of pregnancy and eclampsia may be followed by chronic renal disease (p. 107), and bacillus coli infections of the urinary tract, so often acquired during pregnancy or the puerperium, may become chronic. The deleterious effect of pregnancy and parturition on such conditions as cardiac disease, renal disease, tuberculosis and diabetes must also be remembered.

Ante-natal Supervision

By "ante-natal supervision" (or "ante-natal care") is meant the systematic supervision of pregnant patients. The process of childbirth has for its ideal result a healthy mother in possession of a healthy child. How far this ideal is from being realised in all cases the student is now well aware; he has learnt that the failures fall into four great groups: (1) maternal mortality; (2) maternal injury and ill-health; (3) fœtal death; (4) infant mortality and morbidity consequent on fœtal injury and disease. Most of the complications of pregnancy and labour and, therefore, most of the fatalities, injuries and diseases, both maternal and fœtal, which result from childbirth can be prevented by early diagnosis and treatment during pregnancy. Ante-natal supervision is therefore the great preventive branch of obstetrics.

Amongst the important complications preventable by ante-natal supervision may be mentioned the following:—

(1) Most cases of difficult or obstructed labour, by the timely diagnosis during pregnancy of pelvic contraction, excessive size of the fœtus, breech and transverse presentation, and pelvic tumours. All these are important causes of maternal and fœtal mortality, and of puerperal infection.

(2) Eclampsia and the other severe toxæmias by the prompt discovery of slight albuminuria and other early symptoms of toxæmia.

(3) Fœtal death, which is believed to be capable of a 50 per cent. reduction. There are no more prolific causes of fœtal injury and disease than contracted pelvis, breech and transverse presentation, the toxæmias of pregnancy and syphilis; from these risks, as well as from most of the others mentioned in Part VII., the fœtus can be well protected by maternal supervision during pregnancy.

(4) The serious effects of pregnancy in such maternal states as cardiac disease, chronic renal disease and tuberculosis.

(5) Puerperal infection, which is especially liable to occur after prolonged or difficult labour, or serious operative interference.

The foregoing may be regarded as the major aims and objects of ante-natal supervision. What may be termed the minor, but nevertheless important, objects have already been dealt with under the management of pregnancy on p. 92, viz., diet, exercise, clothing, avoidance of constipation, and care of the nipples in preparation for suckling.

The pregnant woman must be examined often enough to protect her from the preventable complications of pregnancy and labour, but frequent physical examinations are quite unnecessary. Too frequent examinations and too much fussiness on the part of her doctor will give the patient a wrong impression that pregnancy is a disease and that danger is to be expected. Vaginal examinations in the early weeks of pregnancy are unnecessary and women object to them. It is especially during the last six weeks of pregnancy that physical examination is of high importance; for it is during this period that faulty presentations can be discovered and corrected, and estimation of disproportion between the head and the pelvis can be made.

The earlier in pregnancy a woman consults her doctor the better he can help her. At the first consultation she should be told the hygienic rules to be followed (p. 92); the date of expected delivery should be calculated (p. 207), the general health investigated and the urine and blood pressure tested; the abdomen should be palpated to feel the size of the uterus (p. 80) and the external pelvic measurements taken (p. 372). If the patient is already in the later months of pregnancy, a vaginal examination should be made to measure the diagonal conjugate and to exclude pelvic tumours; the presentation should be diagnosed and the relation of the head of the fœtus to the pelvic brim determined. Pelvic measurements should never be omitted, for although the ultimate test of pelvic contraction does not rest on them, but on the presence or absence of disproportion between the head and the pelvis, it is wise to learn at an early date if induction of premature labour or Cæsarean section is likely to be required, in order that the

patient and her friends may be warned of the possibility, and that the necessary arrangements may be anticipated.

It is impossible to lay down a rule as to how often and at what periods of pregnancy a woman should be examined ; it depends on the requirements of her case. In a normal case not more than four examinations are necessary. The first is the early consultation (*vide supra*). The second should come about the end of the seventh lunar month, when, if a vaginal examination has not been already made, it should be made now in order to measure the diagonal conjugate, to estimate the size of the pelvic outlet, and to detect an ovarian or other pelvic tumour. The third and fourth examinations have for their special purpose the discovery and correction of faulty presentations and the relation of the head to the pelvic brim. An appropriate date for the third examination is at about the thirty-fourth week, and for the fourth examination at about the thirty-eighth week of pregnancy. In cases of pelvic contraction or of other abnormalities the patient must, of course, be examined with a frequency appropriate to the requirements of her case.

In a primigravida the head should have become well engaged (p. 378) by the thirty-sixth week, and should remain well engaged from that date onwards ; if it is still above the brim a bimanual examination must be made to ascertain if the head can be pressed into the pelvic cavity (p. 389). In doubtful cases of disproportion it is wise to give an anæsthetic. Failure of engagement of the head may be due to pelvic contraction, to excessive size of the fœtus, to placenta prævia, to a pelvic tumour or to a loaded rectum. In about 20 per cent. of normal primigravidæ the head remains above the brim, and does not become engaged until shortly before full term, or until labour has begun ; in such cases the head can be easily pressed down and disproportion thus excluded. In a multipara the head, as a rule, remains above the brim until labour has begun or the membranes have ruptured.

If the back of the fœtus is behind, an attempt may be made to induce it to come forwards by the method described on p. 306. Breech presentations should be converted into head presentations according to the method described on p. 602.

The expected date of labour as calculated by the menstrual or other data (p. 207) should be noted, and care must be taken not to allow the occurrence of dangerous prolongation of pregnancy and the development of a fœtus of excessive size. If labour does not begin within a week of the calculated date the patient should be examined at weekly intervals, and as soon as the impression is gained that there is disproportion between the head and the pelvis, labour should be induced (p. 389).

The importance of the early recognition of the occurrence of albuminuria in pregnancy has already been pointed out (p. 108). Examinations of the urine should therefore be made sufficiently often, in order that eclampsia and the other severe toxæmias of pregnancy may be averted. The urine should be examined early in pregnancy as part of the routine of investigating the state of the general health. Subsequently it should be examined once a month during the seventh and eighth, once a fortnight during the ninth, and at weekly intervals during the last lunar month. The patient is told how to collect and send the samples, and is given a list of dates on which they are to be sent.

If the patient has been pregnant before the details of her previous pregnancies and labours must be noted, for much may be learned from them. A history of a difficult labour or forceps delivery, or of a fœtus born dead, or a child that died shortly after birth, will suggest pelvic contraction; a history of albuminuria or eclampsia in a former pregnancy will suggest special precautions in the present one; the birth of a macerated fœtus or of repeated dead-births will suggest syphilis.

The necessity of ante-natal supervision cannot be too strongly urged. Without it there can be no hope of appreciably reducing maternal mortality and fœtal death, and all the other unfortunate sequels that result only too frequently from childbirth.

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